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

Operation

1.0 Once the start-up procedure has been completed, all moisture has been driven out of the catalyst and refractory and the catalyst activated, the generator heat-up rate is not critical. However, if the generator is allowed to cool to ambient temperature and not be used for a very long time moisture absorption in the catalyst and insulation may re-occur.

If the generator output is not requred for a relatively short period we recommend idling at a lower temperature of 1000°F rather than a complete shut down (Obviously, the lower the idle temperature the longer it will take to return to operating temperature but also the lower the temperature the less expensive it is to idle). The atmosphere pump should be turned off and the temperature controller set to the idle setting. Upon restarting, set the temperature controller to 1900°F. Restart the pump when appropriate. Remember to reset the alarm to 1700°F when the generator is put back into service.

2.0 When the endo-generator is to be shut down, push the “INJECTOR GAS STOP” button and the “INJECTOR PUMP STOP” button and turn off the “ZONE ALLOW” switches for 1, 2 and 3. This will cause the “ENDO MIXTURE” and “BURNER” lights to go out. Once the lights are out push the “BURNER GAS STOP” button. Close the generator process gas output to furnace(s) valve(s). Close the ball valves between the heat exchangers and the output manifold. Open, then shut, the heat exchanger drain valve(s).

2.1 When the atmosphere production of any one retort is to be shut down, turn off the “ZONE ALLOW” switch for that retort. This will automatically shut down the process gas feed to that retort when the burner light goes out. Close the ball valve between the heat exchanger and the output manifold for the effected retort. A tag should be attached to the control panel reminding the operator to open this valve when this retort is to be returned to service.

3.0 Continuous dew point records are just as important as continuous temperature records. It is important to monitor dew point at both the generator and the furnace. With furnace dew point readings only, the generator may be over-controlled while trying to effect changes in furnace dew point due to furnace leaks. The results can be sooting catalyst when run too rich or decomposing catalyst when run to lean.

4.0 Carbon deposits are almost inevitable in endothermic generators. Carbon collects in the catalyst bed slowly at lean air/gas mixtures which are producing normal dew points and rapidly at rich air/gas ratios. When the carbon build-up starts to effect the endothermic gas being produced, a “carbon burn-out” is required.

There is a differential pressure gage installed on the unit to measure pressure drop across the retorts. It is useful and important to note the pressure reading when the unit is first started. As the flow through the retorts becomes restricted by carbon deposits on the catalyst, this pressure reading will increase. Note the reading at which the dew point control degrades or the process gas flow is not sufficient to meet demand. This reading can be used in the future as an indication of the need for a burn off cycle.

As a matter of reference, the pressure drop across “clean” retorts at full system flow is usually less than 10” w.c. With time and use that pressure differential will normally increase. If the differential increases to something above 20” w.c. (or signifcantly higher than the initial reading for your system) it may be an indication of sooting and may suggest a burn-out as being desirable. The experience of a number of operating TDI systems suggests a normal differential pressure operating range of 5” w.c. to 40” w.c. It should be noted that higher system flows may produce higher differentials. It should also be noted that the numbers noted here are only for relativity. The actual readings on any given system will be unique to that system.

If the generator is run above 40°F Dew point, it may take weeks before a carbon burnout is needed. If it is run above 50°F dew point it may never require a carbon burnout. The rate of carbon build-up is also directly affected by the volume of endothermic gas being produced. A generator running at full capacity may require a carbon burnout sooner than one run at reduced capacity. The life of the catalyst may be reduced by the frequency of burnout’s.

The carbon burnout procedure is described in section 6.

5.0 The catalyst is a nickel impregnated refractory ceramic. The ceramic can withstand temperatures above 2800°F; far beyond what the retort containing it can stand. However, if the temperature is high enough the ceramic will lose its bond and break down into powder in the presence of reducing gas. There are two conditions which can cause abnormally high temperatures in the catalyst bed:

5.1 Excesssively lean air/gas ratio:

Operating with an abnormally lean air/gas ratio (above 3:1) can make the chemical reaction in the catalyst bed exothermic (releasing heat) instead of endothermic (requiring heat). Such a mixture is readily detected because it produces atmosphere with high dew point. The water condenses in the gas heat exchangers and piping to the furnace. If such a condition is of short duration little or no catalyst will be lost and the generator can be brought back to normal operation. If the condition lasts too long and a significant amount of catalyst is destroyed, it can be brought back to normal operation for only a short time before the dew point of the atmosphere begins to rise.

Occasionaly a generator can be operated with decomposed catalyst by using an abnormally rich air/gas mixture. The atmosphere produced may have the desired dew point for a while but analysis would show a high level of unreacted hydrocarbons. In this case the dew point is not a reliable indication of the carbon potential of the atmosphere and in critical processes work spoilage might result.

5.2 Rapid carbon burn off:

Burning off carbon is an exothermic reaction, which produces a reducing gas and possibly high enough temperatures to destroy catalyst. Use the technique described in section 6.

6.0 Carbon burn off procedure.

CAUTION! The burnout of a sooted up retort can be a critical operation. It involves burning fuel (carbon) that has built up inside the retort and may produce very high temperatures. No part of the carbon burnout or burn off procedure should be unsupervised.

6.1 Shut off the process gas flow to the furnace, redirecting the generator output to the vent for burn off.
Single burn-off of all retorts simutaneously (Preferred).

6.1.1 Reduce chamber temperature to minimum above low set point (About 1450°F).
6.1.2 Lean mixture ratio to approximately 5:1.
6.1.3 Watch for blue or orange flame at the vent and monitor output dew point.

Burn-off of a single retort.

6.1.4 Shut off isolation valves to all retorts ***EXCEPT*** the retort being burned off.
6.1.5 Reduce chamber temperature to minimum above low set point (About 1450°F).
6.1.6 Lean mixture ratio to approximately 5:1.
6.1.7 Watch for blue or orange flame at the vent.

6.2 As soon as the flame disappears at the process gas vent and the process gas dewpoint stabalizes at a high point the burn-off is complete and the system may be returned to normal operation.

6.2.1 Reset chamber temperature to normal (1850°F).
6.2.2 Restore fuel ratio to normal operating setpoint.
6.2.3 Open isolation valves (if closed).
6.2.4 Open process valve to furnace.

6.3 The flame at the vent port may be anywher from blue to bright orange. An orange flame is an indication of the amount of accumulated carbon. This flame is a result of the burning of the soot accumulated in the retort. Disappearance of the flame is an indication that the carbon has been consumed. As soon as the flame disappears the system may be shut down or returned to operating conditions.

Ordinarily this process takes about 1 to 4 minutes. There is no need to continue the burnout process after the disappearance of the flame. Don't continue to push air through the retort after the blue flame disappears because doing so may re-oxidize the catalyst which will require reactivating the catalyst.

6.4 The dew point will be very low until all the carbon in the catalyst bed has been burned. When the carbon has been completely consumed the dew point of the atmosphere will rise. This rise in dew point is a positive indication of carbon removal.

6.5 After a complete carbon burnout, if CH_4 still accompanies high CO_2, or if the dew point required cannot be met, the catalyst should be replaced.

6.6 The probe is not damaged by a normal burnout with a lean air/gas mixture. However, the probe temperature should be monitored throughout the entire burnout procedure to ensure that the probe temperature does not rise above its normal operating point during the burnout. A rapid burnout could cause thermal shock damage to the probe. If the temperature is observed to rise shut off the flow of atmosphere to the probe for 15 minutes then gradually restart it.

Although the probe is designed to withstand the normal operating and burnout temperatures of the system, it’s not designed to withstand the thermal shock resulting from a rapid withdrawal from its hot chamber. If the probe must be removed from a hot system it must be removed very slowly; two inches every 5 minutes or so should provide enough cooling time to avoid breaking. Consult the manufacturers manual for the hot removal procedure.

The probe can be used to monitor the progress of the burnout. When all of the soot is burned out, the probe output reading will drop to a low value.