Maintenance and Safety Checklists for an Endothermic Gas Generator

by
Daniel H. Herring
"The Heat Treat Doctor"®

Endothermic Gas Generator Operational Maintenance and Safety

Maintenance Considerations

Maintenance of an Endothermic gas generator is critical to the operational success of the heat treat department, and as essential as on any furnace or piece of machinery in the manufacturing operation. The maintenance of the unit is a team effort between the Heat Treater and maintenance department. It is strongly recommended that a detailed log be kept of not only the maintenance performed, but the operational condition based on a daily review of the generator performance. The Heat Treater is the first line of defense in helping to spot and track changes in generator performance.

A simple checklist based on our experience and that of others [1], [2], [3] is provided below to make the task easier. Follow all plant safety precautions (and apply common sense) if performing any of these checks with the equipment running.

Daily/ Shift Checks

The daily maintenance routine should be as follows:

- ❑ Check the temperature control instrumentation to confirm that the generator is operating at the proper temperature
- ❑ Check for proper flow and pressure of the generated atmosphere
- ❑ Check that the floats in the gas and air flow tubes are free and operating normally
- ❑ Check for proper inlet air-gas ratio

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

- ❑ Check that the compressor is operating and functional
- ❑ Check either the gas analysis or the dew point of the unit. Make sure that any manual and automatic readings coincide. Recalibrate automatic gas analyzers.
- ❑ Check that the gas cooler is operating properly. If installed check the temperature of the exiting gas (to confirm that the carbon reversal reaction is not occurring (and that soot is not being formed) at the gas discharge from the generator to the furnace.
    - ❑ If the system is water cooled, check sight drains or temperature gauges (or both) to confirm proper water flow, pressure, and temperature.
    - ❑ If the system is air cooled, check for dirt or obstructions in and around the cooling fins. If a fan is used, check the filter and confirm proper air flow.
- ❑ Check that there are no leaks from any of the joints on the process retort, particularly at the point of entry of the process gas from the compressor
- ❑ Make sure atmospheric burners or pilots (or both) are lit and protected from drafts
- ❑ Check the heating chamber and (if possible) visually confirm it is incandescent.
    - ❑ If gas fired, check the combustion equipment including pilots, spark igniters, and flame rods for proper operation. Check burners for proper ignition and combustion characteristics
    - ❑ If electrically heated, check the current draw on the heating elements.
- ❑ Check the burnoff stack to confirm ignition of flammable atmosphere gases
- ❑ Check for proper operation of the exhaust hoods and stacks
- ❑ Monitor the carbon monoxide (CO) level in the immediate area of the generator (confirm it is < 0.01%)
- ❑ Check for evidence of excessive temperature in all areas of the generator.
- ❑ Check hand valves, manual dampers, adjustable bypasses, valve motors, and control valves for smooth action, proper position and adjustment.
- ❑ Check all pressure switches for proper pressure settings
- ❑ Check blowers, compressors, and pumps for unusual noise or vibration. If possible, check belt tension.

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

- ❑ Check for evidence of damage, from any cause.

Weekly Checks

A weekly check should be conducted on the unit, which is designed to be more intensive than the daily check and should comprise the following (additional) steps:

- ❑ Burnout/regenerate the catalyst as per the manufacturers' recommended instructions.
- ❑ Remove the air filter from the compressor, clean and/or replace
- ❑ Once the burnout/regeneration is complete, start the gas making procedure. Check either the gas analysis or the gas dew point, or both
- ❑ Make sure the flame sensing equipment is in good condition, properly located and free of foreign debris.
  - ❑ Clean the burner flame rod
  - ❑ Check ignition spark electrodes for proper operation and gap
- ❑ Test thermocouples and leadwire for shorts and loose connections. Check for proper insertion depth. Inspect protection tubes for sagging or cracks
- ❑ Test visible and audible alarm systems for proper functionality

Monthly Checks

The monthly checks are designed to deal with items needing less frequent inspection and are as follows:

- ❑ Remove the floats from the flow meter glass tube and clean the internal and external surfaces of the flow meter and re-assemble. Change the flowmeter oil (if necessary).
- ❑ Check the thermocouples for calibration
- ❑ Check the output pressure at the compressor
- ❑ Check the instrumentation for calibration. This means temperature as well as gas analysis or dew point

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

- ❑ Test interlock sequences of all safety equipment. Manually make each interlock fail, noting that related equipment closes or stops as specified by the manufacturer
- ❑ Test pressure switch settings by checking switch movements against pressure settings and comparing with actual impulse pressure.
- ❑ Inspect all electrical devices for proper current and voltage and be sure that all electrical contacts and switches are functioning properly
- ❑ Clean or replace the air blower filter
- ❑ Clean any filters or strainers
- ❑ Inspect burners and pilots
- ❑ Check ignition cables and transformers
- ❑ Test automatic and manual turndown equipment
- ❑ Test pressure relief valves; clean as necessary
- ❑ Check backpressure regulators; inspect and clean/replace diaphragms

Quarterly Checks

The quarterly checks that should be performed include:

- ❑ Inspect the catalyst. Refill if necessary to the recommended level, or replace if required
- ❑ Inspect and clean the burners. Check the gas train for functionality
- ❑ Disassemble, inspect and rod out, if necessary, the gas cooler. Look for obstructions or blockages and clear them
- ❑ Inspect and clean any drop lines in the gas delivery line from the generator to the furnace and clean. Disconnect the exit line from the gas cooler and check if there is soot present (this will indicate if there are problems with the gas cooler and possibly clogged delivery lines).
- ❑ Check all safety solenoids, and safety controls

Semi-Annual Checks

The semi-annual checks are as follows:

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

- ❑ Inspect the retort (inside and outside), heating chamber insulation, and all external components including heat exchangers and such ancillary items (if installed) as refrigerators and dryers. Repair or replace as necessary.
- ❑ Lubricate the instrumentation, valve motors, valves, blowers, compressors, pumps, and other components
- ❑ Replace all thermocouples
- ❑ Test instrumentation and other electrical components.
- ❑ Test flame safeguard units
- ❑ Burn out carbon in the retort(s).
- ❑ Check for blockage/plugging of hot pipes, tube bundles, and jacketed pipes.

Important Note

It has been our experience that when the subject of the necessity for and frequency of catalyst burnout/catalyst regeneration is discussed a great deal of confusion exists within many companies. We have been involved in solving numerous problems involving Endothermic gas generators and furnace atmospheres. We are frequently asked "is it important that I burn out my generator?" Our answer is an unequivocal, YES!

Following the equipment manufacturer's recommendations for burnout of an Endothermic gas generator is a simple and effective way to keep your operation in control and avoid (costly) problems or service visits. The frequency of burn out recommended by the equipment manufacturer should be followed. The manufacturer issues an Operation and Safety manual and it should be carefully reviewed prior to initiating a burnout and followed precisely. If the generator has been manufactured off shore and the manual is in a foreign language, then visit the local college or look for a translation service and have it translated into English.

Remember, proper maintenance procedures will protect the company's investment in both the short and long term.

Safety Considerations

Start-up Issues

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

Like any other furnace that uses a combustible gas, great care must be taken when both starting up and operating Endothermic gas generators. Under no circumstances should you consider putting any combustible gas mixture into the process retort under 1400ºF (760ºC), otherwise there is a real and immediate danger that a serious explosion will occur and can result in serious injury or death as well as significant damage to the equipment and surroundings. The generator is really just a furnace and requires the same knowledge, understanding and application of all applicable safety standards. The manufacturer's instruction manual and safety procedures should be thoroughly reviewed and strictly followed. All personnel should be properly trained.

When starting up a new generator or after a shut down of an existing one, the unit should be raised to its operating temperature slowly to reduce the risk of thermal shock and the potential for cracking of the furnace refractories and the process retort. This aspect of the heat up is most important.

Once the process temperature has been reached, the air gas compressor can be started. Once the compressor is operating, the main process gas can be opened. Set the air to gas ratio at approximately 2.4 to 1. This may very slightly depending on the process gas analysis depending on the location the process gas source.[2]

Having covered the major maintenance issues of Endothermic gas generators, we move into the various safety components and their functions. Here again, these components, in order to perform their functions as intended, require regular maintenance.

Typical Components

Typical safety components[3] provided on an Endothermic gas generator are shown below (Note: RX® is a registered trademark of Surface Combustion, Inc. and is used here because it is a common term used in the heat treating industry to refer to the gas produced by an Endothermic gas generator). CAUTION: your actual equipment may vary depending on manufacturer and type of retort heating system. Remember to check your manufacturer's operating and maintenance manual as well as all applicable federal, state, and local codes.

- *Main Gas Low-Pressure Switch* - Prevents flow of gas when the supply-gas pressure drops below the normal operating pressure.

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

- ❑ *Main Gas High-Pressure Switch* - Prevents flow of gas when supply-gas pressure rises above normal operating pressure.

- ❑ *Low-Air Pressure Switch* - Prevents flow of gas in the event of loss of adequate combustion air pressure.

- ❑ *Main Burner Gas Safety Shut-Off Valve* - Automatically closes in the event of the following conditions: low gas, high gas, low air, over-temperature of the retort.

- ❑ *Reaction Gas (*RX® *Gas) Low-Pressure Switch* - Stops the flow of reaction gas in the event reaction-gas pressure falls below normal operating pressure.

- ❑ *Reaction Gas High-Pressure Switch* - Stops the flow of reaction gas in the event reaction-gas pressure rises above normal operating pressure.

- ❑ *Reaction Gas Safety Shut-Off Valve* - Automatically closes, stopping flow of reaction gas supply in the event of the following conditions: low RX® gas pressure, high RX® gas pressure, high temperature limit, retort below 1400ºF (760ºC), mixture pump failure, closing of the fire-check valve.

- ❑ *Reaction Gas Fire-Check Valve* - Closes in the event reaction gas burns back into the retort-supply piping.

- ❑ *Reaction Gas Micro-Switch* - Prevents start of reaction gas mixture pump when three-way RX® gas valve is not in the burnout position.

- ❑ *High Temperature Limit* - Interrupts flow of both burner gas and RX® gas in the event the retort temperature exceeds safe limit. Or, in the case of electrically-heated retorts, interrupts the power to the heating elements as well as RX® gas supply.

- ❑ *1400ºF (760ºC) Interlock* - Prevents start of mixture pump if retort temperature is below 1400ºF (760ºC).

Note: These examples are meant to be generic in nature. Local codes and specific insurance carriers may require variations to these safety systems. Always follow your

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com

equipment owner's manuals for exact equipment configuration and set-up instructions, and comply with your insurance carrier's regulations.

References:

1. Beck, A. J., *Heat Treat Engineering*, Heat Treating Magazine, 1972.

2. *Furnace Atmospheres and Carbon Control*, ASM International 1964

3. Parizek, Douglas., *Maintenance of Endothermic Generators*, Heat Treating Conference Proceedings, ASM International, 1999.

4. Herring, D. H. and David Pye, *Understanding the Endothermic Gas Generator* HOT TOPICS in Heat Treating and Metallurgy, Vol. 2 No. 1 (January 2004).

The HERRING GROUP, Inc.
Home of *"The Heat Treat Doctor"*
P.O. Box 884
Elmhurst, Illinois 60126-0884
Tel: 630.834.3017 / Fax: 630.834.3117 / Cell: 630.640.9048
E-mail: dherring@heat-treat-doctor.com / dherring@ameritech.net
www.heat-treat-doctor.com