

CATALYTIC HEATER APPLICATIONS AND COMMON ISSUES

Shih-Shin Chou

Bruest Catalytic Heaters

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Introduction

Natural gas catalytic infrared heaters are commonly used for space heating in hazardous locations and for pilot gas heating in pilot driven regulators.



Figure 1: example pilot gas heater installation

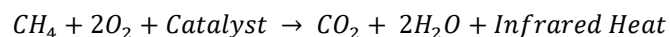
Natural gas catalytic infrared heaters are often selected due to their hazardous area ratings. While they are known mostly for heating gas for pilot regulators, catalytic heaters can be used in other natural gas heating applications.

Gas catalytic heaters are easy and safe to use. Following best practices and procedures will ensure optimal performance.

Fundamentals

Natural Gas Characteristics

Natural gas has an auto ignition temperature between 1200°F/649°C to 1400°F/760°C. At these temperatures, the gas can self-ignite, leading to an explosion. Catalytic heaters reducing the combustion temperature natural gas through the introduction of the catalysts in the following equation:



The catalyst reduces the temperature of this process to between 800°F/426°C to 900°F/483°C in a flameless reaction. The infrared heat produced is an invisible light that will heat up whatever absorbs it. The infrared energy does not heat up the air.

The catalytic reaction can only start when the catalysts have reached a minimum temperature of 350°F/177°C. Catalytic heaters are put into operation with electric preheat. Once operational, catalytic heaters will require sufficient fuel and oxygen to operate.

Catalytic Heater Basics

Natural gas catalytic heaters will typically have the following components:

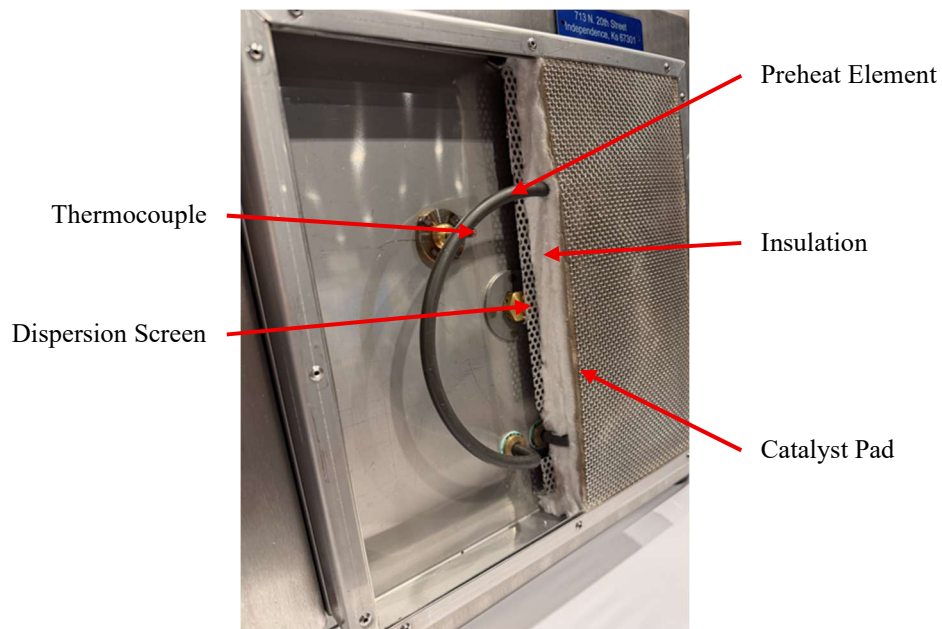


Figure 2: Typical components of natural gas catalytic heaters

Due to the nature of their construction, the typical catalytic heater is not field serviceable.

Basic Operation Steps

Catalytic heaters have minimum operating temperatures before gas can introduced. These basic steps should be followed to ensure the heaters will operate correctly.

1. Apply power – this can be 12VDC, 120VAC, 240VAC, or even 480VAC
2. Wait 15 to 20 minutes to preheat the catalyst
3. Open the safety valve
The thermocouple and the safety valve work in pairs to ensure gas is only introduced when the heater is ready. Bypassing the safety valve can create a hazardous situation and should not be done.
4. Wait another 15 to 20 minutes
This step ensures that the entire heater catalyst area is ready. This is step is often missed.
5. Remove electric power
While it is not strictly necessary to remove electric power, leaving the electric power on for extended periods of time can reduce the longevity of the preheat element.

The following figures show thermal images of each of these steps.

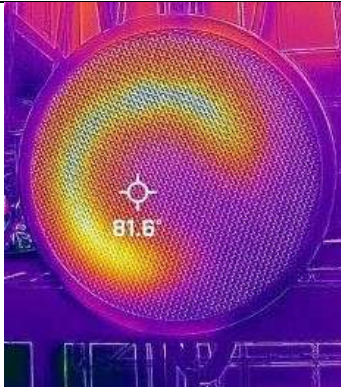


Figure 3: Heater in preheat mode with electricity applied



Figure 4: Gas valve opened after 15 minutes. Notice warmer spot where gas is catalyzing

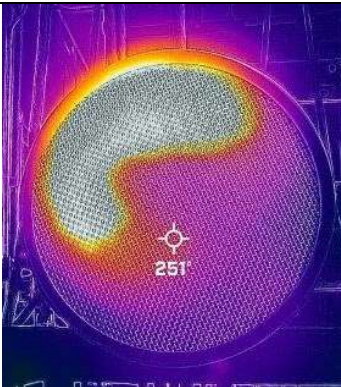


Figure 5: Two minutes after gas is introduced

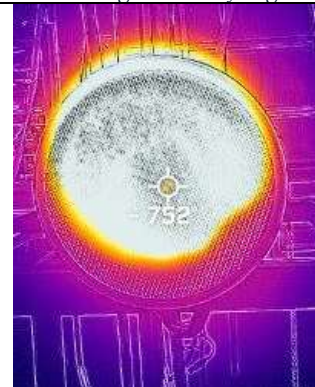


Figure 6: Full 15 minutes after gas has been introduced with the electric power still applied

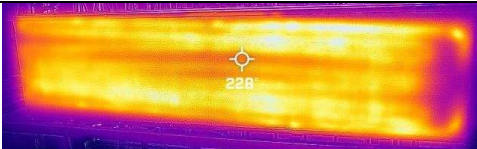


Figure 7: Electric preheat only on 12X60 heater

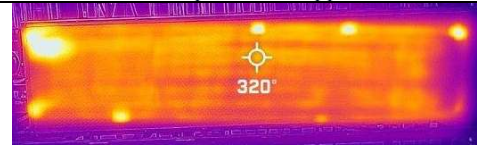


Figure 8: Electric preheat with gas valve first opened



Figure 9: Five minutes after gas is introduced



Figure 10: Fifteen minutes after gas valve first opened

Following the basic operating procedure ensures that the heater is in full readiness before removing the electric power. Skipping step four, waiting an additional 15-minutes after opening the gas valve, is one of the most common causes leading to random heater shut offs.

Common Issues and Resolutions

When applied correctly, gas catalytic infrared heaters can offer years of worry-free usage. There are some commonly reported issues with gas catalytic heaters, including:

- Heaters randomly shut off
- Overheating of instruments
- Gas slippage

These issues can often be resolved with proper operating procedures. There are also some additional components that can be added to reduce the occurrences of these problems.

Heaters Randomly Shut off

One of the most troubling issues is the catalytic heaters shutting off unexpectedly. The operators start up the heater but perhaps do not follow the complete steps. As shown by the Basic Operations Steps, the heater takes approximately 30 minutes to start. However, step 4, waiting an additional 15 minutes after the gas is first introduced, is often shortened or skipped completely.

Insufficient preheating time

The heater will start feeling warm once the gas is introduced after the preheating time. However, as shown in figures 5 for the smaller heater and figure 9 for the larger heaters, the entire heater surface, especially the larger heaters, will not be fully catalyzed. Removing the electric power at this step can result in the heater possibly shutting unexpectedly.

Catalytic pads have excess moisture

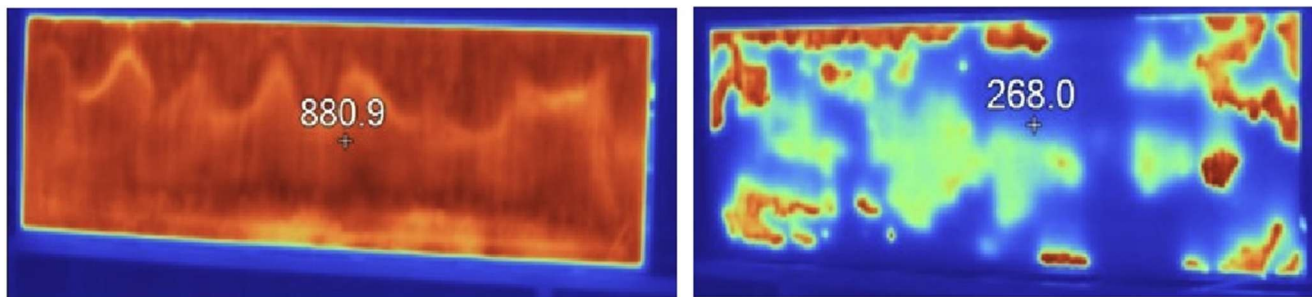
This issue is further complicated if the catalytic heater is left off during the warmer months. In many instances, the gas catalytic heaters are shut off during the warmer months as heat is not required. This will cause the heater's insulation and catalytic pads to absorb moisture from the air. When the units are first started in the fall, it will take longer than the minimum suggested time of 30-minutes for the heater to reach full catalyzation as shown in figures 6 and 10. To avoid excess moisture in the heater, the units can be left on running on low power during the summer months. Alternatively, during the initial startup in the fall, applying electric power for extended periods of time (up to 2 hours) may be required.

Inadequate fuel gas supply

Gas catalytic heaters can operate between full power and half power. The fuel gas pressure can be adjusted by either lowering the pressure from the regulator or through a thermostatic control valve. If the fuel gas pressure falls below the minimum allowable value, the heater may continue to operate though at a reduced capacity. Overtime, this reduced capacity can cause the heater to shut off at some undetermined time.

Contaminated Heater

Gas catalytic heaters require clean, dry, sulfur free gas for optimal performance. Sulfur, even in trace amounts, can deactivate the heater over time. Figure 11 below shows side-by-side comparison of a new heater versus the same heater that was contaminated.



IR Image of new heater

IR Image of contaminated heater

Figure 11: Thermal image of new versus contaminated catalytic heater

Contaminated catalytic heaters will continue to output heat though at a reduced rate. Figure 11 shows an extreme example of a contaminated heater. The safety valve would generally stop operating when the heater temperature falls below 350F.

Overheating of instruments

Gas catalytic heaters are often used to heat regulators and valves to prevent these devices from freezing up. See example installation in Figure 12.



Figure 12: Example enclosure heater on a regulator; gas train shown with temperature controller

These enclosure type heaters are selected due to their simplicity for installation. The enclosures are clamped-on style, allowing them to be applied without having to modify the piping or the instrument. The heaters apply heat directly on the regulator body. While this arrangement is acceptable when the station is flowing gas, it is possible that the regulators can overheat should the station flow drop below 50% of maximum condition.

These installations are often done without any temperature control. The heaters are placed into service at full power. When the station is flowing at maximum volume, the heat does not create any issue. However, as the outside temperature and the gas volume change throughout the day or week, the constant heat applied to the regulator can often lead to overheating situations. As shown in Figure 12, the addition of a temperature controller to the gas train can reduce the overheating risk.

Gas Slippage

Unlike a typical combustion burner, gas catalytic heaters have a maximum input fuel gas pressure. They are designed to work best between the rated full and half pressure as shown on the heater tag. Having the correct gas train components, with the proper setting, will help to ensure the optimal heater operation. Example gas train components are shown below.

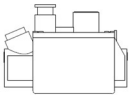
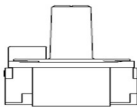
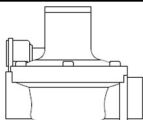
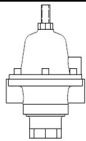
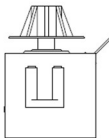
 Baso Valve	 Appliance Regulator
 Low Pressure Regulator	 High Pressure Regulator
 Temperature Controller	

Figure 13: Typical gas train components

Figure 13 shows the various components that can be used with typical gas catalytic heaters. Depending on the hazardous rating of the location, an appliance regulator may be needed. Properly setting the fuel gas pressure will not only help to ensure the heater works correctly but also prevent gas slippage situations.

When using temperature controllers, it is important to note that these temperature controllers can have fuel gas bypass orifices that need to be adjusted to ensure sufficient fuel is being supplied.



Figure 14: Example temperature controller showing the location of the low fire adjustment orifice

Figure 14 shows the adjustment orifice for one type of temperature controller often used with gas catalytic heaters. To set the low fire pressure, first start the heater as discussed previously. Set the temperature dial to the lowest setting. Check the low fire pressure. Adjust the bypass orifice as needed to ensure that the low fire pressure is at or above the minimum required by the heater. Check this setting regularly to ensure the minimum pressure is still correct.

Common Issues and resolutions summary

More often than not, catalytic heaters that do not behave as expected are due to improper startup procedure, inappropriate or missing fuel gas components, or improper settings of the gas train. Ensuring that the heater has been fully preheated, with a minimum of 30-minutes of electric preheating, before removing the electric power can prevent a majority of the random shut off errors. Ensure that the heaters have the proper fuel gas pressure at full and half power settings. By using a temperature controller, the gas catalytic heaters can automatically operate between full and half power without the user having to change the gas pressure manually. Finally, the heaters need sufficient air to operate. Make sure the vent holes are not sealed off to allow for sufficient draft.

Applications of Gas Catalytic Heaters

The three most common applications of the gas catalytic heaters are space heating, pilot gas heating, and enclosures wrapped around a regulator or a valve. Examples of each are shown below.



Figure 15: Catalytic heater in spacing heating application



Figure 16: Thermal images showing 60F increase from unheated area



Figure 17: Pilot gas heating for two pilot regulators



Figure 18: Single pilot heater



Figure 19: Enclosure heater



Figure 20: Enclosure Heater with frosted pipe

Figures 15 through 20 shows typical example gas catalytic heater applications. Their hazardous location rating allows them to be installed near the devices that need heating. This reduces the space required. Figure 15 and 16 shows the heaters in a space heating application. Unlike traditional heaters, catalytic heaters do not heat air. Rather, catalytic heaters emit infrared heat that is absorbed. As shown in Figure 16, the concrete flooring temperature has increased by 60 degrees versus the non-heated area. This targeted approach, versus heating up the entire space, makes it possible to use lower energy for heating while achieving the desired heating result.

Figures 17 and 18 show the typical pilot gas heating application. A pilot regulator sees the same differential pressure as the main regulator. However, due to its smaller orifice, the pilot regulator can freeze up sooner than the main regulator. The addition of the pilot gas heater can help reduce the occurrence of pilot regulator freezing.

Figures 19 and 20 shows example enclosure heaters around a common regulator used in the natural gas industry. The enclosure heaters are selected primarily due to their ease of installation. These types of heaters are often clamped on style. They simply go over the regulator to provide direct heating of the regulator body. This simplicity does require some consideration beyond installation though. The enclosure heaters are often close to the regulator body. This allows the heaters to keep the regulator from freezing when the volume of gas is constant or near the maximum demand rate. This closeness can cause the regulators to overheat should the gas volume decrease, which is often the case not only throughout the day but also throughout the operating season. As discussed previously, the overheating issue can be reduced with a temperature controller in the gas train. By adding the controller, the enclosure heater can offer the desired heating results with reduced overheating risk.

Additional Application for Catalytic Heaters

Natural gas will lose 7° of heat for every 100 pounds of pressure drop (1° per 15 PSI). Therefore, natural gas pressure regulation equipment such as control valves and regulators can experience freezing issues even in warm climates. For example, a pressure regulation station that regulates the pressure from 700PSIG to 50PSIG in 75°F weather can still experience freezing ($75^{\circ}\text{F} - (7^{\circ} * 650 / 100) = \sim 30^{\circ}\text{F}$). Catalytic heaters, due to their ability to be installed in hazardous locations, can be used to prevent freezing situations where small amount of heat is required.



Figure 21: Regulation station with "minor freezing" problem



Figure 22: "Minor" freezing regulation station



Figure 23: Catalytic Heaters (Twin-Paks) with 48,000 BTU input



Figure 24: Regulation station after heaters installed, achieved 41F actual versus 35F estimated

Figures 21 through 24 shows a small regulation station that was experience a “minor” freezing problem. Two catalytic pipeline heaters (Twin-Paks) with an input rating of 24,000 BTU each were installed without modifications to the station. These clamp on pipeline heaters use the pipe as the heat exchanger, minimizing the installation tasks. The station achieved a gas temperature after regulation of 41°F versus 35°F estimated.

These catalytic pipeline heaters are suitable for applications that require low amount of heat. For larger stations, catalytic heaters can also be designed to achieve inputs up to 3.5MMBTUs. Since catalytic heaters do not need an exhaust chimney, even high BTU rated catalytic heater system can offer lower profile than the typical heating system.



Figure 25: Regulation station before heater installation



Figure 26: Large catalytic heater (500K+ BTU) installed next to gas station and across from houses

Figure 26 shows an example of a line heater rated at over 500K BTU input installed roadside across the street from houses and next to a gas station. The compactness of the catalytic line heater, low emissions, and no noise during operation, allowed it to be installed in this location.

Conclusion:

Catalytic heaters are safe and effective heaters that can be used in hazardous locations. Following proper startup procedures can help to ensure the heaters operate as expected. Updating the gas train with temperature controller options can help improve the operating range of the catalytic heaters. Finally, the expansion of catalytic heater design have allowed it to be used in applications beyond the typical pilot gas or space heating applications.