INTRODUCTION/BASIC OPERATION

HEATER TYPES

There are two general types of gas-fired heaters, Indirect and Direct. ***INDIRECT FIRED HEATERS***, like a residential furnace, burn gas inside a metal tube called a heat exchanger. The air that is used to heat the application is heated indirectly when it is passed around the tubes. This air never comes in contact with the flame. The combustion products from the flame inside the tubes are exhausted through a flue pipe to the atmosphere. ***DIRECT FIRED HEATERS*** burn the gas directly in the air stream. The products of combustion are included in the air that is used to heat the application.

HEATER THEORY

Energy (heat) must be added to a specific volume of air in order to change its temperature. Gas fired heaters create heat by burning gas. Heat is measured in BTUs (British Thermal Units). This is a measure of heat, not temperature.

Temperature vs Heat

The temperature changes when the energy of a specific volume of air increases or decreases. Energy (in the form of heat) is added to a volume of air and changes the temperature. When this energy is added to different volumes of air, different temperatures are achieved. To further illustrate this point, let's look at how to calculate temperature rise, i.e. the difference between the air temperature after it is heated, and before it is heated.

$$\Delta T = 0.8 \times \frac{BTUs}{CFM \times 1.08}$$

Temperature Rise Calculation for Indirect Fired Heaters

$$\Delta T = \frac{BTUs}{CFM \times 1.08}$$

Temperature Rise Calculation for Direct Fired Heaters

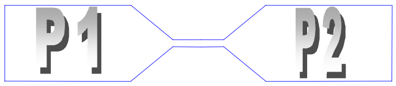
These equations show that if the CFMs increase, and the BTUs remain constant, the temperature rise will **decrease**. Conversely, if the CFMs decrease and the BTUs remain constant, the temperature rise will **increase**.

Static Pressure vs HP

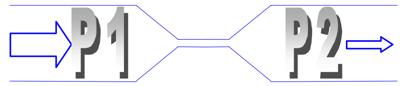
Construction of the ductwork connected to a supply unit is another element in understanding heater operation. Some of the essential elements in understanding ductwork are static pressure, blower curves, and motor amperage. Static pressure is the pressure created in the duct by the flow of air. As air is forced through a section of duct, it exerts forces on the walls of the ductwork containing it. The measurement of this force is static pressure, and is commonly measured in inches water column using a device called a manometer. As a rule, air travels easily in a straight line and does not like to turn. When we force air in a duct to turn or transition, the air exerts even more force on the walls of the duct and we create more static pressure. As the static pressure increases, the blower moves less air due to the resistance in pushing (or pulling) the air through the duct. This decreases the amount of current that the motor is using to turn the blower wheel (lowers the motor amperage). This relation can be seen on a blower curve, which plots CFMs vs. static pressure as a function of blower RPM and motor horsepower.

Gas Flow

Another critical element in understanding heater operation is gas flow. Gas pressure changes based on flow rates. A simple example of this is shown in the following illustration, where a portion of the plumbing is smaller in the middle. This could represent a device in the line such as a gas valve. Note in the first illustration, with no gas flow, there is equal pressure in both sections of the pipe (P1 equals P2). In the second illustration, where the gas is flowing, the second section of pipe has much less pressure than the first (P2 is less than P1).



No gas flow. P1 = P2



Gas flow from left to right. P1>P2.

This is important because the incoming gas pressure is often measured when the heater is not running. Even though the line may appear to have the appropriate pressure, the pressure will drop when the heater is operating. If the gas supply system is sized properly, the upstream regulator will compensate for the drop, and increase the pressure to the heater.

Another important part of heater performance relates to the heating value of the fuel. Natural gas has Methane as its main constituent, while LP consists of Propane. The same heater is capable of burning both of these fuels, however, the volume required for LP is roughly half the volume required for natural gas for the same BTUs. This is because natural gas (380,000 BTU/lbmol) has a heating value that is approximately half the heating value of Propane (955,000 BTU/lbmol).