YORK	ECO2 ROOFTOP MODULATING GAS HEAT APPLICATION GUIDE	
APPLICATION GUIDE	Initial Release	Form 100.50-AG1 (0305)

INTRODUCTION

Continuing in the innovative tradition of the YORK rooftop design, YORK maintains the leadership position with the introduction of high turndown, induced draft modulating gas heat. Available in three different capacities, the YORK offering provides the following customer benefits:

- **Low installed cost** – induced draft design does not require adjustment to linkage and combustion assembly that a power burner requires.
- **Precise temperature control** – provides the ability to improve load matching, improve occupant comfort, and increase reliability with less furnace cycling.
- **Redundant heating** –750 mbh and larger furnaces are modular designs with redundant furnace capacity. 750 and 1125 mbh furnaces have two and three separate furnace modules, respectively. The second (or third) furnace module can provide heat to the building while another module is down. This provides 100% redundancy under light heating loads.

The YORK Eco2 modulating gas offering combines the highest turndown with a very low minimum capacity at an affordable cost. With the modulating capability, the YORK design offers operation at low gas pressures, provides enhanced heating reliability, flexible capacity selection, as well as the same benefits that the standard staged furnace offers.

FURNACE TYPE SELECTION

<u>Staged vs. Modulating furnaces</u>

Staged furnaces tend to be simpler in nature, cost less and operate at discrete capacities, or steps. Stepped capacity control is not unique—in the cooling mode, compressors stage on and off to control supply air temperature. In variable-air-volume (VAV) rooftop applications, it is common for the heating to only operate in the morning warm-up mode. It is often selected as a precautionary measure to allow for supplemental heating in the event there is a building control problem, or as a backup heating source. For these applications, a staged furnace is the most common.

In constant volume (CV) applications, the airflow is constant, and the temperature is varied. With staged heating, the temperature rise across the furnace takes stepped increases in temperature as shown in Figure 1 as the solid blue line. Each “step” of capacity corresponds to a step in the supply air temperature, and results in a wider dead band of operation around the desired setpoint.

By contrast, the modulating control is shown with the red dotted line in Figure 1, illustrating that the heating capacity can be closely matched to the demand to provide finely tuned temperature control. A modulating design allows the system to zero in on the capacity and minimize cycling of the furnace(s).

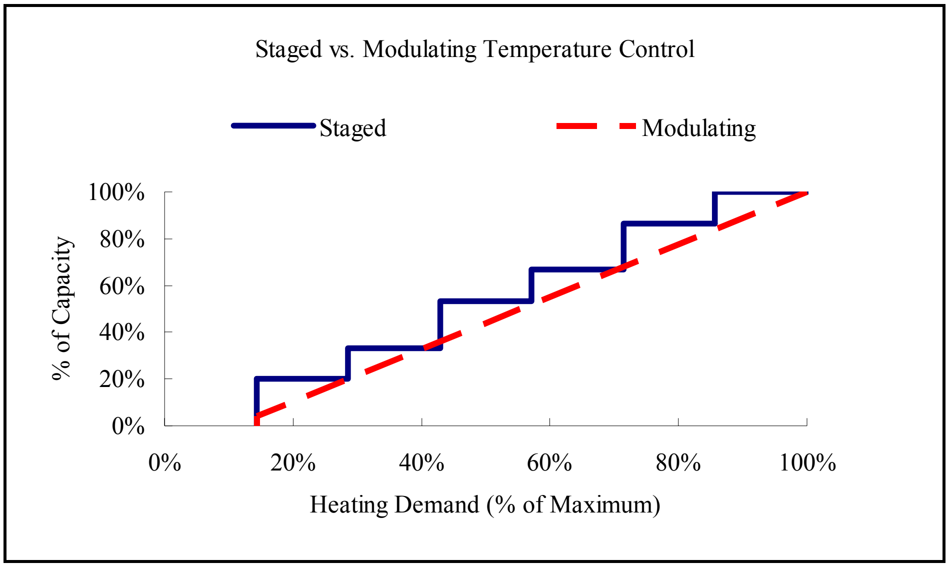

Figure 1: Staged vs. modulating heat comparison showing how the capacity heating output can be matched to the heating demand.

Benefits of High Turndown Ratio

The YORK furnace design offers industry leading performance for unsurpassed temperature control with a leading 24:1 turndown ratio. Even the smallest furnace (375 mbh output) provides 8:1 turndown capability.

Turndown is essential when lowering the airflow in a given application. As the airflow reduces, the temperature rise for a given furnace output increases. Wherever possible it is ideal to be able to reduce capacity at the same time the airflow decreases in order to keep the tightest control on the supply air temperature.

For example, assume that the YORK 375 mbh furnace has 24,000 cfm at design, and a minimum airflow of 8250 cfm. At minimum airflow and minimum furnace output, the temperature rise yields the following:

ΔT = (37,500 Btuh) / (1.08 x 8250) = 4.2°F

By contrast, a competitive 500 mbh (4:1) or 850 mbh (6:1)[1] furnaces yield 11.6°F and 13.1°F temperature rises, respectively. A minimum step of capacity in both cases means that the supply air temperature can fluctuate by more than 10°F, potentially overheating the air and causing occupant discomfort, or causing the air delivery devices (i.e. VAV boxes) to cycle open and closed in what is often called "hunting". This commonly requires a building automation system to apply a wider deadband around the supply air temperature.

An additional benefit of the modulating furnace over the staged is higher energy efficiency and reduced furnace cycling. Energy efficiency is improved because the air is not being overheated and cycled as the temperature rises above the supply air temperature setpoint.

Induced vs. Forced draft furnaces

Manufacturers use various types of furnaces, however in packaged equipment, the most common are induced and forced draft furnaces. A forced draft furnace consists of a power burner that creates a positive pressure inside the heat exchanger and pushes the flame into heat exchanger and expels the combustion products out the flue stack. By contrast, the induced draft furnace has an inducer fan on the discharge of the furnace that creates a negative pressure in the heat exchanger and draws the flame through the heat exchanger.

One inherent advantage of the induced design is the operation at a negative pressure in the heat exchanger. In the event of a heat exchanger leak, conditioned air from the occupied space leaks INTO the heat exchanger and out of the unit to the atmosphere through the flue. If a forced draft furnace heat exchanger leaks, there is the potential for combustion products to leak into the conditioned air and into the occupied spaces. This, of course, is dependent on the relative pressure between the conditioned air and the exhaust gases in the flue.

Forced draft drum-style furnaces operate under conditions where exhaust gases are likely to condense. They condense because they operate at temperatures closer to the combustion gas condensing temperature. The condensate that can form in drum-style furnaces is acidic in nature with traces of acids that can corrode heat exchanger surfaces. The typical drum-style furnaces must often use higher grade stainless steel for this reason. This often results in increased first cost to the owner.

One advantage of forced draft furnaces is their ability to reach higher heating capacities. A single furnace can be used to provide 1000 mbh heating capacity, whereas an induced draft furnace uses multiple smaller furnaces. The advantage of the induced draft heat exchanger design is the ability to have heating redundancy in the event a furnace fails. If a single forced draft furnace fails, heating is lost at the most inopportune time—winter, when it is coldest outside.

[1] Source : Trane Intellipak Catalog RT-PRC010-EN, March 2003

The YORK induced draft furnace design also provides another benefit for winter operation. As the temperature drops, a greater demand is placed on the gas utility which can reduce gas pressures delivered to the site. The induced draft furnace can operate reliably at gas inlet pressures as low as 3.5 inches water gauge for full capacity versus the typically recommended 6-7 in. water gauge for power burner applications.

MODULATING GAS FURNACE

Modulating Gas Heat Option

The modulating gas heat configuration is available with one, two and three 375 mbh input furnace modules yielding 375, 750 and 1125 mbh heating with 8:1, 16:1 and 24:1 turndown, respectively. This combination of sizes and turndowns provides the highest degree of temperature control and redundancy in commercial rooftops. A diagram of the furnace section is included in Figure 2.

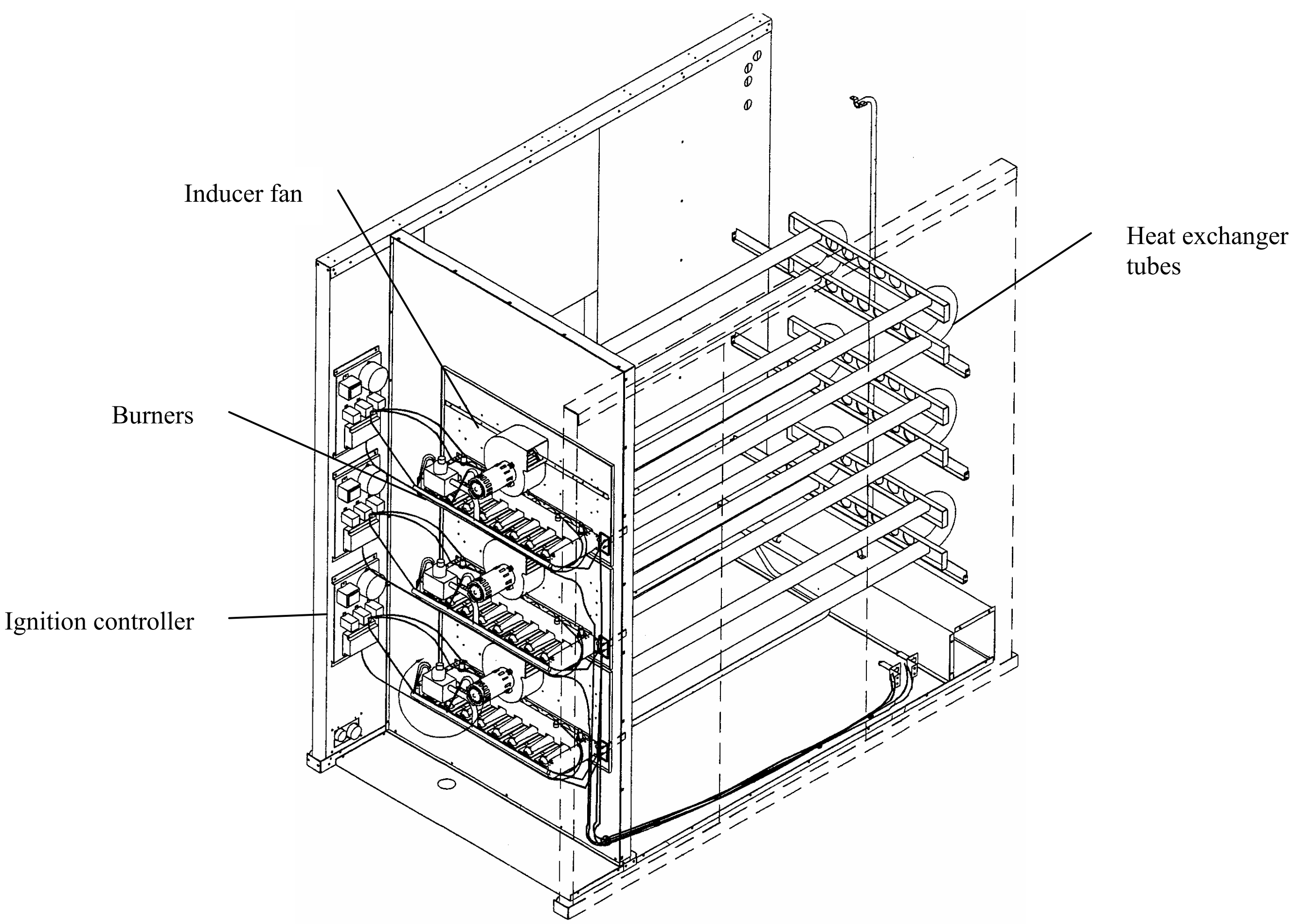

Figure 2: 1125 mbh output gas furnace section.

One furnace module includes a modulating gas valve, signal conditioner, ignition control, flame safeguards, air proving switch and safeties. The other modules are two-stage furnaces which load and unload in sequence with the modulating furnace to provide a modulating output characteristic for excellent temperature control at full and off-design airflows.

The following information is provided to outline the basic operation of the modulating furnace in each of the four primary modes of operation: morning warm-up, supply air tempering, occupied VAV heating and normal heating.

Morning warm-up

The morning warm-up control sequence is utilized in the early morning hours, typically during cold or cooler months, prior to building occupancy. Morning warm-up is used to raise the space temperature up to a comfortable level from the typically cooler, night setback space temperature setpoint.

Sequence of operation - The unit controller will initiate the morning warm-up sequence via a BAS command, or binary input, a first stage heating call (W1 contact closure) in the unoccupied mode, or via a time-clock. Upon this signal, the rooftop unit control will close the outside air damper (if open), energize the VAV heat relay to inform the system that the VAV boxes should be driven to their open position and start the ignition sequence. The ignition sequence begins by starting the supply fan and ramp it up to full airflow. Note, duct pressure is maintained to avoid over-pressurization and damage to the ductwork. The ignition control pre-purges the furnace, then opens the gas valve to minimum fire, and ignites the flame via direct-spark ignition. Upon establishing a flame, the unit will ramp up to full fire.

Morning warm-up will conclude when either the return air temperature reaches the Morning Warm-up setpoint or the morning warm-up timer expires, whichever comes first.

Supply air tempering

Supply air tempering is used when mixed air temperature is below the supply air temperature. This occurs anytime the outside air is cold enough, or high enough volume to drive the mixed air temperature below the supply air temperature setpoint for cooling. For example, consider a 20,000 design cfm system that requires a minimum of 10,000 cfm of outside air and the airflow is as low as 10,000 cfm when all of the VAV boxes are closed. At this condition, the airflow into the ductwork is 10,000 cfm of outside air. If the outside air temperature is 40°F, it will need to be heated up 15°F to the supply air temperature setpoint.

This can be accomplished by cycling a staged heater, or using a modulating furnace. When available, a modulating furnace should be used to minimize temperature variances, lower energy use, and improve occupant comfort.

The YORK Eco2 modulating gas heat provides the tightest temperature control in the industry with high turndown ratios and low minimum capacities. This combination allows the unit to control the temperature rise to smaller increments than competitive rooftop products.

The smallest Eco2 furnace provides 300 mbh heat output with 8:1 turndown—this means a minimum capacity of 37.5 mbh versus competitive furnaces that only go down to 125 mbh. In this case, the Eco2 can provide a temperature rise that is 1/3 of the competitive furnace.

Sequence of operation - Supply air tempering is initiated when the SAT drops below the supply air tempering offset from the SAT setpoint. When this occurs, the furnace sequence is initiated to turn on a furnace. The furnace will modulate to minimum fire and ramp-up to maintain the SAT setpoint.

Occupied VAV heating

Heating can be required during VAV operation in colder climates. In this mode, the supply air temperature setpoint of the delivered air is warmer. When needed, the Eco2 unit can allow a furnace to modulate output to maintain the SAT setpoint while the unit is modulating airflow to maintain duct static pressure.

Occupied heating (constant volume operation)

The last control function for the gas furnace is basic occupied heating operation for constant volume applications. In this mode, the gas furnace is modulated to maintain a consistent supply air temperature in the heating mode. Modulating capacity allows the unit to accurately adjust its output capacity to match the changing building load conditions.

Summary

Understanding the type of application is critical in selecting the appropriate furnace size and type. For applications where tight temperature control is needed, the rooftop unit is the only source of heat, or higher minimum outside air is required, a fully modulating furnace is preferable. However, when a project budget is limited, and it is necessary to reduce the first cost of the system, staged gas heat can provide a valid alternative and adequate control, In either case, York can satisfy the building requirements with either the staged or the modulating furnace design at an affordable cost.

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Form: 100.50-AG1 (0305)
Supersedes: New Release