IFGR

Instruction, Operation and Start-up Manual Supplement

FOR INDUCED FLUE GAS RECIRCULATION SYSTEMS
GAS, LIGHT OIL OR COMBINATION

PRINCIPLES OF OPERATION

This system of induced flue gas recirculation (FGR) has been used extensively to reduce NOx emissions. As the name implies, a portion of the combustion products exiting the boiler are recirculated and introduced into the combustion air supply. From this, at least two phenomena occur that reduce the nitrogen oxide formation. First, since there is a reduction in the percent oxygen in the flue gases when compared to ambient air, the resulting mixture of air and flue gases will have a reduced percentage of oxygen. Combustion in an atmosphere of reduced oxygen percent helps limit the formation of NOx. Second, because of the increased mass flow through the combustion process, the flame temperature is reduced, also resulting in less NOx formation.

This process reduces the NOx formation caused by high flame temperatures (thermal NOx) so the amount of NOx reduction is much greater on gas than oil. Oil has a much greater quantity of total NOx generated with much of the NOx being "fuel bound nitrogen" that is unaffected by FGR. It is important to remember that each boiler has its own unique operating requirement. Two boilers of the same size with the same equipment can have different combustion properties and requirements. With different size boilers, these can be large differences in combustion properties. For these reasons, specific values or setup requirements cannot be made.

NOTE

The major portion of the FGR system start-up is the burner. Therefore, the burner instruction manual should be reviewed and used along with this manual.

This manual has been prepared to assist in the installation, operation and startup of your flue gas recirculation system. It is good practice to know as much as possible about a piece of equipment before trying to install and operate it. Read the contents carefully before proceeding.

NOTE

Installation requirements and instruction should always be covered in appropriate engineering drawings and specifications which detail the applicable building codes, etc. Information contained herein is to be used as a guide ONLY and not as the final authority.

GENERAL

- Starting a burner and FGR system is an event which normally culminates the efforts of several different contractors, manufacturers, utility and engineering concerns, sales and factory representatives, and others.
- In order for the system to operate safely and meet its design capabilities, the interfacing fuel, air, electrical, exhaust and plant heating control systems must be properly sized, selected, installed and tested. Additionally, all conditions must be such that the heat generated by the burner can be safely used or wasted without endangering personnel or equipment.
- No responsibility is assumed by the manufacturer, or any of its employees, for any liability or damages caused by an inoperable, inadequate or unsafe burner-FGR condition which is the result, either directly or indirectly, of any of the improper or inadequate conditions described above.

NOTE

This inspection should be performed before the burner start-up specialist is called in. An incomplete or inadequate installation may require additional time and effort by start-up personnel and cause an untimely and costly delay.

- To insure that a safe and satisfactory installation has been made, a pre-start inspection is necessary. This inspection must be performed by an individual who is thoroughly familiar with all aspects of proper boiler/burner FGR installation and how it interfaces with overall plant operation.
- See the burner instruction manual for major inspection items that must be considered.
- The results of this inspection will often times identify corrections that must be made prior to start-up as well as point out potential or long range problems in plant operation if corrections are not made.
- Burner start-up is a serious matter and should not be viewed as a time for “crowd gathering” by unconcerned, uninformed or unauthorized personnel. The number of persons present should be held to an absolute minimum.
- Instruction of operating and other concerned personnel should be done after the burner has been successfully fired and adjusted by a qualified service agency or factory start-up specialist.

MAJOR COMPONENTS OF FGR SYSTEM

FGR INLET BOX

The FGR inlet box pulls flue gas from the stack and delivers it to the combustion air fan inlet.

FGR FLOW CONTROL DAMPER

The flow control damper is designed to regulate the quantity of flue gas to the FGR inlet box. It is a single blade damper designed for high temperature operation. It is driven by a damper actuator.

FGR DUCTWORK

This ductwork provides for the flue gas routing from the stack to the flow control damper and inlet box. Because of physical variation at each job site, the location of the actual ductwork will vary. For this reason the company does not supply connecting ductwork. Due to the wide variation of duct operating temperature, expansion joints must be provided in the ductwork.

The duct, FGR damper and inlet box assembly will operate at high temperature and should be insulated to prevent accidental burns where installation locations so require. The ductwork must be installed to be gas tight with high temperature gasketing at duct joints. FGR ducting should be sized such that the pressure drop between the stack and burner inlet does not exceed 1 inch w.c.

Ductwork should be made of material suitable for the temperature, pressure, flue gas composition and support requirements of the installation.

The sizing, routing and installation of the FGR line can affect the burner performance, and therefore good engineering practice must be followed during its design. The FGR line should be connected to the stack or breaching before (upstream of) any boiler outlet damper, draft control damper, or barometric damper.

To assist with inducing flue gases the FGR line will commonly extend into the stack or duct and is cut or formed to provide a "scoop". The scoop section is centered along the centerline of the duct and faces into the flow, allowing the velocity of the boiler exhaust gases to push into the FGR line.

Draft controls or barometric dampers are required for the following conditions to ensure repeatable burner performance:

1. Boilers with stacks greater than 30 feet above grade
2. Multiple boilers discharging into a common stack or breaching
3. Long or complicated breaching runs (i.e. multiple directional or elevation changes)
4. Systems where outdoor temperature changes, humidity changes or wind adversely affect the draft pressure

Temperature and pressure in the boiler room both have an effect on the excess air levels with which the burner operates. Since low NOx burners require a tighter control of the range of excess air under which the burner operates, provisions must be taken to control these conditions. If the temperature and/or pressure variations in the boiler room cannot be controlled sufficiently to allow repeatable operation of the burner, the addition of control components such as oxygen trim may be required.

Flue gases contain a high level of water vapor resulting from the combustion process. When allowed to cool, these gases may condense, particularly at any low points in the system. Provisions to drain this condensate may need to be made to prevent its collection. Units which cycle regularly will have typically a higher degree of condensation than units which run continuously due to the continual heating up and cooling down of the equipment.

FGR DUCTS TEMPERATURE SWITCH -OPTIONAL

This switch is used to shutdown the burner in the event the temperature in the ductwork exceeds some maximum set point. This prevents damage to FGR components due to backflow from the boiler in the event of a major FGR system failure.

FGR SYSTEM START-UP

Due to wide variations in engineering specifications, state and local codes, utility, insurance, and underwriter requirements, etc., the contents herein are of a general nature. If additional information is required, or if questions rise concerning specific requirements, please contact your local representative or the factory.

CAUTION

This manual has been prepared as a guide in FGR system start-up operations. It is written for the start-up specialist who is thoroughly qualified both by training and experience. Servicing must be done only by fully trained and qualified personnel.

CAUTION

The burner should always be operated with the FGR damper in operation. Failure to do so can result in damage to equipment, unreliable operation or high emissions.

When setting FGR rates two emissions analyzers are required. One must be used to monitor the stack O2 levels, CO, and NOx emissions. The other analyzer should be used to observe the oxygen content in the burner housing, which is an indication of FGR level. The graph in figure 1-1 (see page 4) can be used to determine the FGR rate, given the stack O2 and housing O2 levels.

Typically the low-fire setting of the FGR damper is fully closed, as there will be sufficient leakage around the damper to provide the necessary FGR at low fire. If the FGR leakage rate is too high around the damper, even when fully closed, problems lighting the burner or unstable low fire operation may result. This can be caused by either trying to set the burner low fire position at too low of a firing rate, or by a faulty FGR damper.

Upon starting the burner it will take several seconds for flue gases to reach the burner, depending on the length and routing of the FGR line. During this time a slight fluttering of the flame may be observed or heard. Once sufficient flue gases reach the burner the flame appearance will change and this fluttering will cease. The burner firing rate should not be increased until this has happened. If the fluttering is excessively loud or results in noticeable physical vibration of the equipment, it is typically an indication that the low fire light off position has been set at too high of a firing rate. Units which cycle repeatedly may experience operational problems if the burners are not allowed to reach steady state conditions before changing firing rate.

If the NOx at low fire is too high, the characterized linkage or FGR valve servo can be adjusted to open the damper allowing more FGR into the system. When adjusting FGR it is very important to make very small adjustments to damper position and then observe readings and burner operation. Small adjustments to FGR damper position, particularly at low firing rates, can result in large changes to the FGR rate.

In addition, since the FGR is being pulled into the combustion air fan along with the combustion air, and the fan is a constant volume device, increasing the FGR rate will lower the combustion air flow,

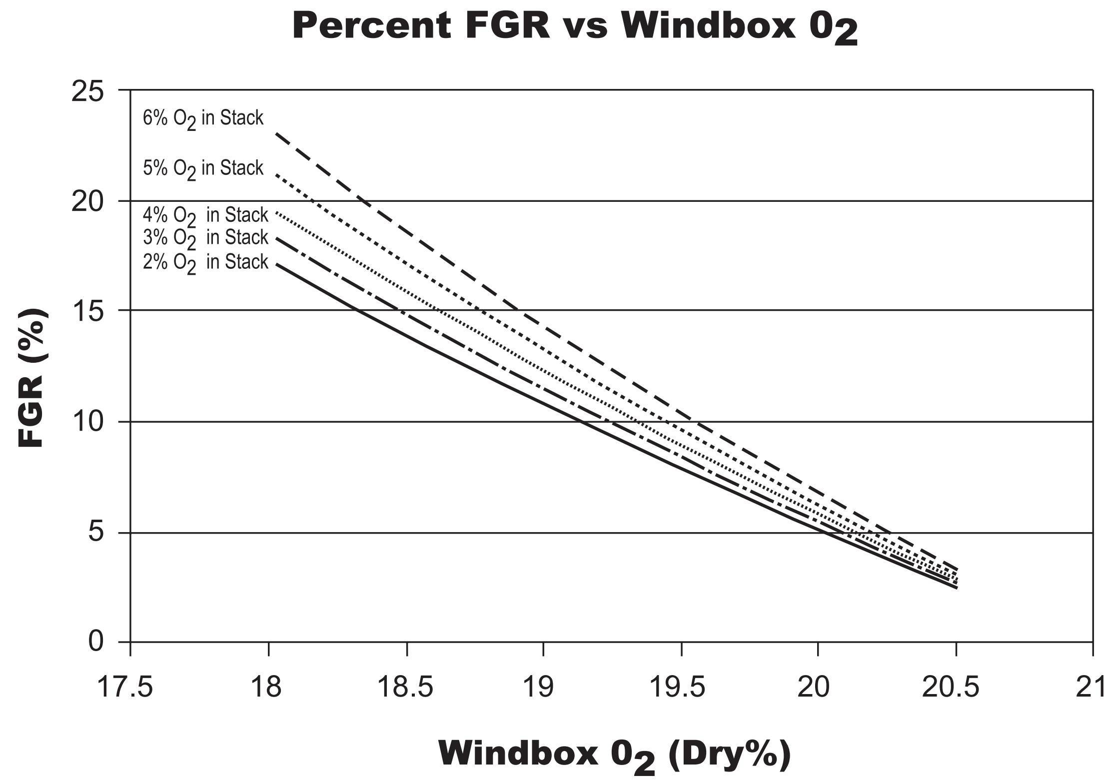

Figure 1-1

which will be indicated by lower stack O2 levels. Conversely, reducing the FGR rate will increase the combustion air flow, which will be indicated by higher stack O2 levels. It may therefore be necessary to make some adjustments to the air inlet louver position when adjusting the FGR damper position.

Too much FGR can cause instability and combustibles (CO or smoke), and too little FGR can cause high NOx and combustion noise. It is therefore important to fine tune the FGR damper position at each firing point to obtain the optimum balance of emissions and burner operation. Excess air rate also affects combustion stability and emissions, with lower excess air levels resulting in lower NOx formation. The excess air rate should be adjusted to the minimum level that produces acceptable combustion performance and CO emissions at each particular load point. Typically this will result in excess air levels ranging from 30 to 40% (5 to 6% stack O2 dry) at low fire to excess air levels of 10 to 20% (2 to 4% stack O2 dry) at high fire. The excess air level should not be set lower than 10% (2% stack O2 dry) at any load point.

Once the FGR rate and excess air rate has been optimized at low fire the burner firing rate should be increased slightly to the next load point. The FGR damper position and air inlet louver position should now be adjusted at this load point. The burner should be stepped up to high fire in this manner, making FGR and air inlet louver adjustments at each operating point, until high fire is achieved. Once the high-fire settings are made, the burner should be stepped back down to low fire in the same manner, ensuring that the emissions, excess air, FGR rate, and operational stability of the burner is repeatable on both increasing and decreasing load. Any required adjustments to FGR damper position and inlet louver box position should be made at each load point until the burner can be ramped from low fire to high fire and back while maintaining proper emissions and combustion performance.

Operate the system through several cycles and re-check operation. All pertinent information should be recorded for future reference. The start-up data sheet supplied with this instruction manual should be completely filled out and kept with the manual. This start-up data will need to be sent to John Zink Company for review when reporting any operational or emissions problems with the burner.

NOTE

Failure to follow the instructions provided in this manual supplement, together with the burner instruction manual, regarding the proper installation, tuning, and operation of the burner will void the equipment warranty.