Optimisation of Combustion Air Enhances Boiler Efficiency

JOHN THOMPSON Enviropac boilers are fitted with Lamtec combustion controls for optimising boiler thermal efficiency.

The main purpose of a boiler is to convert the chemical energy of a fuel into heat energy by means of combustion and then to transfer this heat to steam as efficiently and cost effectively as possible.

Gas-fired boiler thermal efficiency is mostly dependent on the waste heat that leaves the boiler via the stack. The amount of heat lost in the exhaust gas is governed by the temperature of the gas and the amount of flue gas going up the stack. Thus improvement in thermal efficiency can be achieved by:

- reducing the flue gas temperature, and
- optimising the amount of combustion air.

There is some interplay between these two factors, but they can be viewed as follows:

Reducing Flue Gas Temperature

The flue gas temperature is determined by the boiler designer. This is a function of the installed heating surface and how effectively this area has been arranged by the designer using heat transfer enhancing techniques. There is little an operator can do to reduce the flue gas temperature of a given boiler other than keeping the boiler clean.

When gas-firing, a reduction of the flue gas temperature of 25°C will improve the thermal efficiency by 1%.

Optimisation of Combustion Air

The amount of flue gas generated in the combustion process is determined by the amount of fuel burned and the volume of combustion air consumed.

The purpose of the burner combustion control system is to ensure that the right amount of oxygen is available for complete combustion at any given load. Oxygen for combustion is usually supplied in the form of atmospheric air which contains 21% oxygen. By measuring the oxygen content in the flue gas leaving the boiler, it is possible to determine the amount of air used. Burners are commissioned by setting up these flue gas oxygen levels to the burner manufacturer’s specifications. Oxygen levels in the flue gas are typically in the range of 2% to 4.5%.

When gas-firing, a reduction of the flue gas oxygen content of 1% will increase the thermal efficiency by 0.3%, provided combustion is still complete (i.e. no significant CO formation or unburnt hydrocarbons present).

Control of Combustion Air

Most modern burner control systems are microprocessor based and utilize servo motors to vary the air and fuel inputs to the burner. These combustion controllers incorporate some form of excess air curve or lookup table to ensure the correct air/fuel ratio is maintained. To cater for variations in ambient air temperature and fuel composition, the flue gas oxygen levels are set slightly higher than ideal, as it is better to have too much oxygen than too little under any firing condition. Insufficient oxygen will result in unreleased chemical energy of partially completed chemical reactions like CO formation. Accurate, repeatable and safe operation over a wide turndown is possible with such controllers and servo motors.

To achieve optimum combustion settings, John Thompson Enviropac boilers are supplied with Lamtec combustion controllers as standard.

Enhanced Control with O2 and CO Measurement

An O2 sensor in the flue gas can be added to the combustion controller to achieve a slightly lower pre-set excess air curve. This system will account for variations in fan performance (due to changes in ambient air temperature and pressure) as well as variations in fuel composition. Efficiency improvements of 0.5% to 1% can be expected with such systems. By adding an additional CO sensor, the Lamtec combustion controller can self-learn the optimum shape of the burner excess air curve. This self-learning is achieved by the controller constantly testing the minimum air/fuel ratio by automatically cutting back on air flow in small increments and checking for the presence of CO, an indication that the minimum possible setting has been reached for the prevailing conditions. With CO control, O2 levels below 2% are possible.

For further information please contact:
Neville Sharwood
Technical Manager – Package Boilers
John Thompson
Email: nevilles@johnthompson.co.za