CO_e Control – Closed Loop Burner Efficiency & Enhanced Safety

Mick Barstow, Regional Sales Manager at LAMTEC, explains how CO_e Control can be used to optimise combustion control to deliver maximum cost and emissions reductions.

Oxygen Trim (O_2 trim) is widely acknowledged as an essential element of burner control that allows boiler operators to reduce both energy costs and associated harmful emissions. Over the past two decades O_2 trim has evolved from basic systems that adjusted mechanical linkages using Bowden cables through to today's sophisticated microprocessor-controlled electronic linkageless burner management systems that employ highly accurate and repeatable servo motors to position air dampers and fuel drives.

The concept of O_2 trim was the result of the development of in-situ zirconia-based flue gas measuring technology. Efficient and safe combustion requires a precise mixture of fuel and air. Too much air results in energy being wasted up the flue; too little air results in incomplete combustion. Incomplete combustion is particularly undesirable and results in the formation of Carbon Monoxide (CO), Hydrocarbons (HC) and Hydrogen in the form of H_2.

To combat the chances of incomplete combustion, burners are always commissioned with an element of 'excess air'. Combustion is complex and there are many variables such as air temperature, humidity, barometric pressure and fuel quality that affect the whole process. Excess air ensures that, even if the combustion variables change detrimentally, the combustion process remains safe.

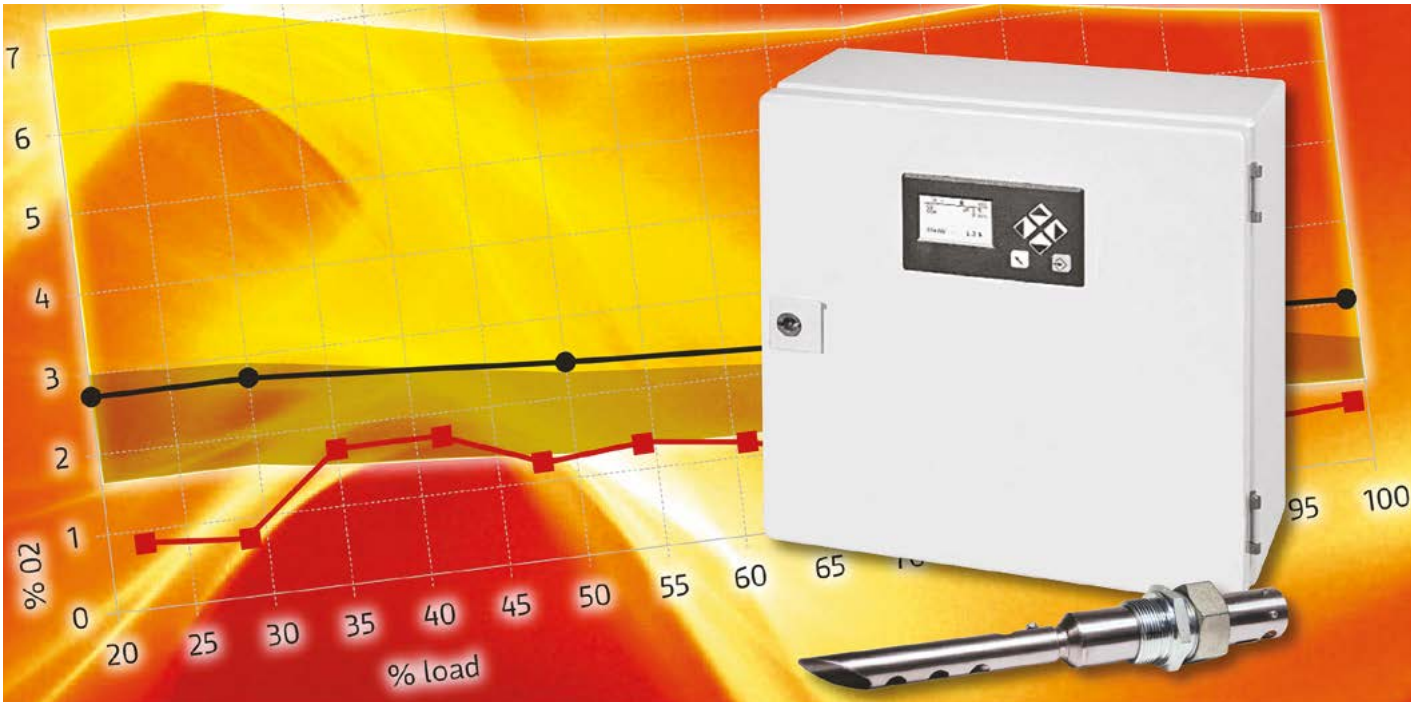
O_2 sensors allow combustion systems to become 'closed loop'. This means that any changes in combustion variables are detected and can be corrected accordingly.

So, how does O_2 trim work? The answer is fairly simple in that it adds or reduces either fuel or air to compensate for changes in these combustion variables. For each point on the combustion profile there is an O_2 setpoint. If the O_2 reading for any point increases, then air is reduced, or fuel added, to bring the process variable back to the setpoint. If the O_2 decreases the opposite happens. Most systems work by adding or subtracting air as this has less effect on the power output. Decreasing air will reduce costs whilst adding air will increase costs. However in the latter case systems will ensure the combustion process remains safe and CO/H_2 is not produced.

In an ideal world, combustion, without excess air, would result in the best efficiency possible; this is called stoichiometric combustion and is a theoretical state where exactly the right amount of oxygen molecules reacts with fuel molecules to complete the combustion reaction. In simple terms, e.g. for methane:

$$\mathbf{CH_4 + 2O_2 = CO_2 + 2H_2O + Heat}$$

CO_e Control takes a more empirical approach that allows combustion systems to get closer to stoichiometric conditions, whilst remaining safe. CO_e sensors use a modified version of zirconia O_2 sensors that enable them to detect the products of incomplete combustion. These include CO, H_2 and HC. This is why the term CO_e is used instead of CO; CO_e is effectively a CO equivalent.



The LT3-F Failsafe Combined O_2/CO_e Analyser and Probe.

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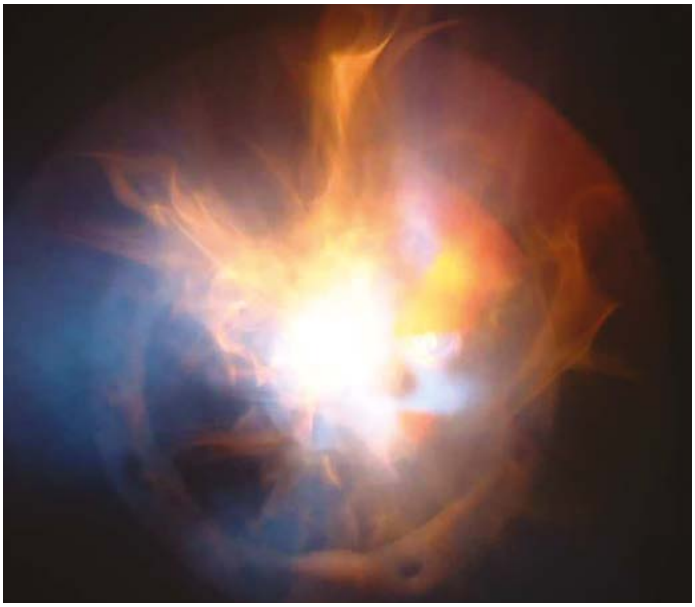
CO_e Control – Closed Loop Burner Efficiency & Enhanced Safety (continued)

CO_e Control produces savings over that of O_2 trim by enabling the burner to operate a fuel/air mixture on the edge of stoichiometric conditions. One important aspect that allows this level of control is the rapid response of the CO_e sensor to the detection of the products of incomplete combustion. CO_e Control is a self-adapting algorithm that 'learns' each point on the programmed combustion curve by reducing air to the point where CO_e is detected and then 'backing-off" to a safe setpoint. After the learning process has been completed, if at any time incombustibles are detected, the system simply readapts by 'backing off" to the next safe position. Each 'learned' point has a lifetime of eight hours after which it is 'learned' again. This ensures that if external conditions have improved then the CO_e Control will readapt to compensate for this and increase efficiency. It is not uncommon for systems employing CO_e Control to run at 1% O_2.

In order to ensure systems employing CO_e Control remain safe, a failsafe oxygen sensor is required. An oxygen level of about 0.4% is typically set as a safety threshold and if the flue gas oxygen level reaches this level then the CO_e Control is switched off and an alarm produced.

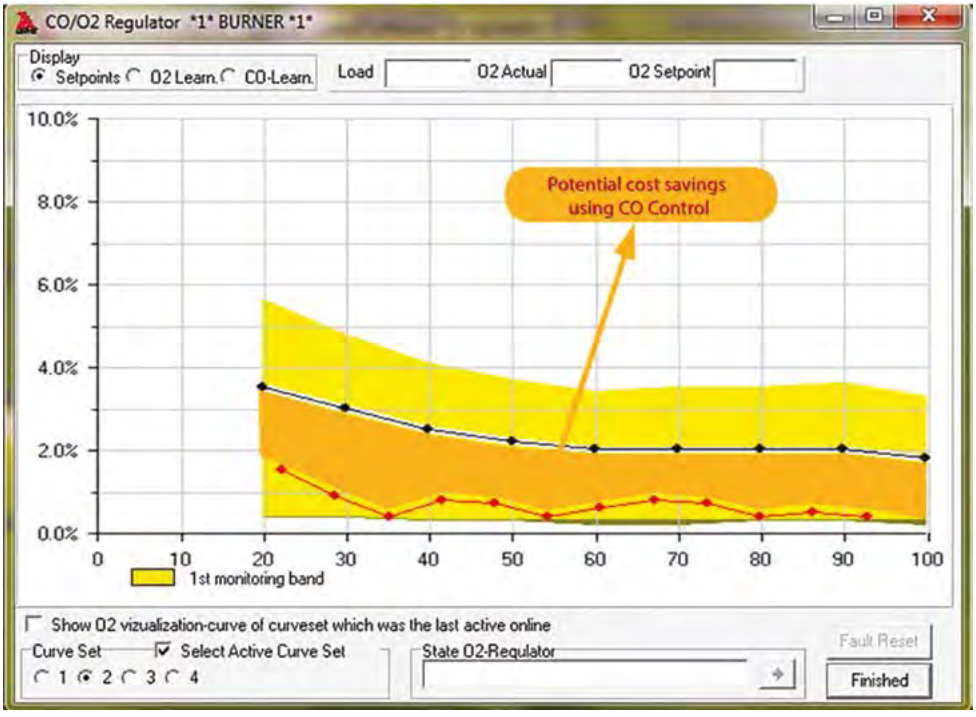
The KS1D is the latest version of LAMTEC's combination zirconia-based probe that detects both O_2 and CO_e. By using the KS1D with the latest LT3-F failsafe transmitter, CO_e control can be implemented using a single probe located in the flue. The LT3-F uses two separate processors to cross-check the zirconia cell's signal reading.

Quantifying cost savings when employing O_2 trim and CO_e Control is always difficult as the starting point, i.e. the base profile set by the commissioning engineer, is somewhat subjective. However, as a rule of thumb, CO_e Control can generate an additional saving of up to 50% over conventional O_2 trim systems.



Efficient and safe combustion requires a precise mixture of fuel and air. CO_e Control enables the burner to operate a fuel/air mixture on the edge of stoichiometric combustion in which exactly the right amount of oxygen molecules reacts with fuel molecules to complete the combustion reaction

CO_e Control has been widely adopted in Europe but its benefits have not yet been recognised in the UK. LAMTEC has extensive experience of CO_e Control and introduced the first systems back in 2004. Since then, over 2,500 systems have been installed. CO_e Control is available as an option on all of LAMTEC combustion control systems from the new BT300 through to the well-established Etamatic and FMS/VMS.



CO & O_2 curves with cost saving area highlighted between the two

What about the Enhanced Safety? One of the inherent problems with O_2 trim is that if ingress air 'leaks' into the system then the oxygen level in the flue or exhaust will increase; the response of an O_2 trim system is to reduce the air, which has a negative effect on the combustion process and causes incomplete combustion, and the resultant CO_e. CO_e Control is a much safer option as it is not affected by ingress air; incomplete combustion is the only source of CO_e so if it is detected then the operator can be sure there is a problem.

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