Operators influence on forehearth operation and production

Forehearth performance optimisation audits identify all factors that prevent a forehearth from operating at optimum efficiency. John McMinn* explains why these audits are important and why furnace operator training is key.

The audit analyses consistently demonstrate that one of the most common factors to negatively impact forehearth operation and pack-rates is the influence of the forehearth operator. Not all operators have high skill levels. Audits have repeatedly identified situations in which production was compromised by poor forehearth performance - yet the operator failed to understand the origin of the problem or to acknowledge a problem existed.

Training

To understand why this situation exists one must consider the level and quality of the training the average operator receives. No forehearth operation textbook exists and in its absence there are two common sources of training.

The first is in-house training where the out-going forehearth manager passes his knowledge onto his successor. This approach often ensures that any bad practice is perpetuated to the next generation with the new operator rarely doubting the wisdom of what he is told. I know of one operator who insisted that a yellow flame in the spout was preferable because yellow flames provide a higher heat input. (This is often confused with visible flames in a furnace, but for a forehearth system the yellow flame temperature could be 800°C lower than a stoichiometric non-visible methane flame). He was taught this by his previous manager and never doubted it to be true.

Incidentally, less than 10% of those responsible for setting the combustion air/gas ratio – the single most important combustion parameter – knew how to calculate the correct value for their plant's gas supply. They simply used the value they had always used without calculating if this figure was correct. The examples are as numerous as they are alarming.

A forehearth system supplier often provides the second source of training. To varying degrees, this type of training is often perfunctory concentrating on the basics required to drive the system – how to change set points, how to adjust the air/gas ratio and how to enter PID values. Unfortunately it seldom equips the operator with the knowledge of what the best set point profile should be for the glass colour, tonnage and forehearth dimensions. Nor does it enable an operator to intuitively recognise a combustion fault based on the traces from the temperature sensors or other diagnostic data. Neither does it provide the ability to analyse and test the control loop response and ensure the correct PID terms are used.

Operator skills

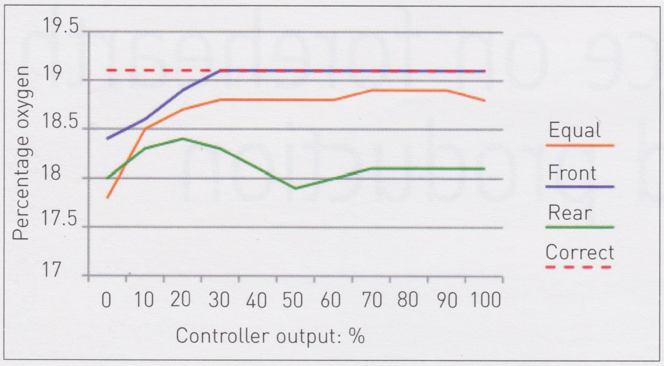
Usually the results of operator shortcomings is reflected in damage to production but in some cases we have identified practices that are potentially damaging to plant and equipment and, in some extremes, pose a serious threat of injury to personnel.

Modern forehearth systems normally provide a wealth of data which, when correctly interpreted, provide the information required to assess the performance status of the forehearth. A deeper understanding of forehearth operation can be obtained from relatively simple tests to determine factors such as system de-calibration, loop response etc. It is within this area where the skill levels of many operators are demonstratively inappropriate.

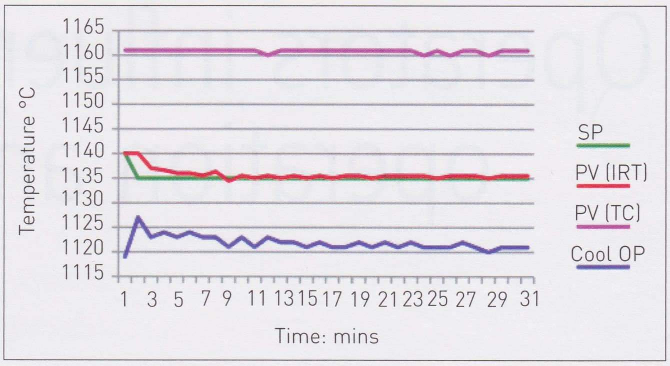
The interpretation of on-screen data is often skewed by the belief that if a value appears on a SCADA screen it must be correct. The heating output to a particular zone may be shown on screen to be 100% yet the set point cannot be achieved. But the output value is no guarantee that the zone is receiving any heat input at all – as shown in **Fig 1** the reason may be de-calibration of the combustion air control valve for the rear zone – or any one of a variety of causes.

The operator needs the ability to assess the data and, crucially, identify the causes while maintaining minimum disruption to production.

continued »



▲ Fig 1. Air/gas ratio percentage oxygen.



▲ Fig 2. TC & IRT response to 5°C SP decrease.

Making parameter changes to a forehearth is often a source of forehearth and production disruption. For example, the set point profile is one of the most frequently adjusted operation parameters and is commonly used to adjust the vertical glass temperature profile at the spout entrance or to accommodate a job change. Altering set points is often seen as a fairly trivial, mundane task yet the act of changing a set point value is crucial to forehearth operation and its impact is rarely appreciated amongst forehearth operators.

During training courses, Forehearth Services ask operators how many times per shift they alter the set points on a particular forehearth and how long they wait to observe the impact of the set point change on the glass temperature. The answers to both vary enormously but the majority is almost always wrong. The number of times a set point should be changed, and the interval between changes, is largely a function of the magnitude of the change and the tonnage and dimensions of the forehearth. It is also dependent on the position of the zone and assumes the appropriate PID values are used – which is normally a big assumption!

But each has a finite number that can easily be calculated but, alas, seldom is. For example consider the desire to raise by 5°C the set point of the rear zone of a 42 inch wide, 20ft forehearth with a pull rate of 100 tonnes per day. The maximum number of changes to the set point can be calculated and, for an eight hour shift, is nine times. Similarly the minimum interval required between changes is calculated to be 50 minutes. If the set point was changed more than nine times the effect of the set point change would not have stabilised and so the further change would add instability to the forehearth with negative effects on forehearth control and, potentially, container quality. Similar problems arise if changes to set point are made within the minimum change interval. It is common to see operators making frequent changes to zone set points and, even worse, making multiple zone set point changes simultaneously. Forehearths are best operated with knowledge and patience in equal measure.

Clearly an operator should be capable of interpreting the data presented by the system and have the analytical ability to determine whether or not the data presented is logical. This requires knowledge not only of the capabilities of the forehearth itself but also of the sensors and field equipment supplying the data.

It is well known that, in terms of forehearth control, radiation pyrometers can be problematic – especially when used on coloured glasses. ***Fig 2*** demonstrates this.

Fig 2 represents a forehearth cooling zone controlled by a fibre-optic pyrometer. In the forehearth configuration used, single tri-level thermocouples are positioned immediately in front of each control pyrometer to provide zone-by-zone vertical temperature profile data.

The zone was subjected to a 5°C set point decrease (shown by the green trace) and, as can be seen from the red trace, after approximately eight minutes, the temperature was apparently reduced until the pyrometer registered the new set point. The operator in charge of the forehearth believed this demonstrated the zone was both well tuned and calibrated.

However, a cursory examination of the chart reveals this was far from the truth. The pink trace represents a thermocouple junction 25mm below the glass surface directly in front of the pyrometer. It can be seen that the decrease in set point has not resulted in a real decrease in glass temperature – even 31 minutes after the set point adjustment. It should have been clear to the operator that only the surface of the glass – the area from which the pyrometer derives its signal, has been reduced leaving the body of the glass unchanged. The same phenomenon has been recorded in many plants throughout the world.

Because of lack of training this was not recognised by the operators who saw the achievement of set point as evidence of good control whereas, in reality, the zone was essentially out of control.

Conclusion

This short paper has only scratched the surface of forehearth control and operation problems related to inappropriate or inefficient forehearth operator training.

Poorly performing operators compromise forehearth operation, impact on container ware quality and pack rates and are often responsible for low fuel-efficient forehearth operation. In short, badly trained operators are costing glass plants money.

Forehearth operation is a skill that can be taught. A competently trained operator will have the ability to predict the effect on the glass of any changes he/she may make to the forehearth – and to predict also the timeframe required for the change to occur.

Forehearth Services provides a modular training course programme covering all aspects of forehearth control and operation. The full course comprises approximately 4000 Powerpoint screens and a 600 page training manual, which combined represent the most comprehensive manual of forehearth technology available. ■

***John McMinn, Managing Director, Forehearth Services Ltd, UK.
Website: forehearthservices.co.uk**