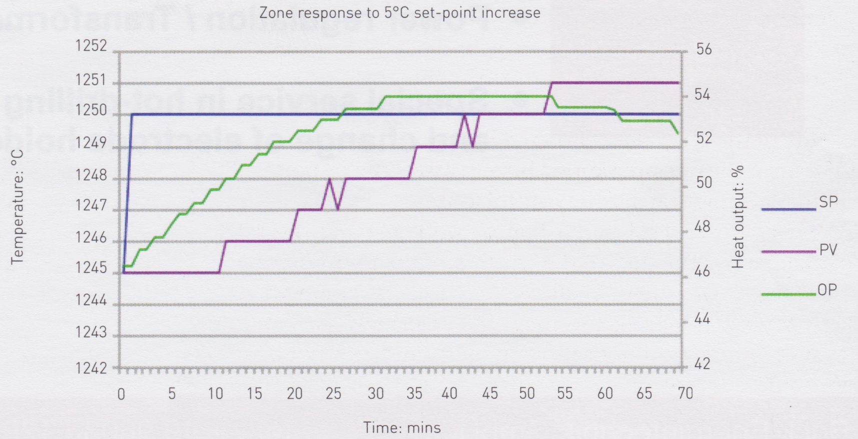
Training and audits optimise forehearth performance

John McMinn* describes how simple checks and a training and audit programme can dramatically improve forehearth performance.

Apart from perhaps a gas meter and the dubious usefulness of an 'efficiency value', derived from equalising zone tri-level thermocouples, there is very little to inform the operator how well (or how badly) a particular forehearth is performing.

It is producing gobs and the production people are not complaining too much – but exactly how does the operator know at what level the forehearth is operating? Could the performance be improved? Is it operating at 70% or 90% potential? In the absence of a 'performance meter' it is basically guess work. Seems OK, so best leave it alone? But leaving it alone costs money in terms of rejected ware, reduced speeds and fuel wastage. Surely, there must be a more technical and measured approach than this? The answer is to audit the performance of the forehearth and to train operators in how to correctly evaluate how well the forehearth and its control, combustion and cooling subsystems are operating.



▲ Fig. 1: Demonstrating a poor forehearth zone.

Forehearth performance

Our experience of auditing a variety of forehearth designs across four continents has shown that sub-optimal forehearth performance is extremely common and is normally associated with a combination of factors rather than purely system de-calibration. A recurring factor is the forehearth operator, and consequently a forehearth performance audit includes an audit of the skills and performance of the operator.

Unfortunately not all operators have sufficiently high skill levels. Frequently, a forehearth audit will identify situations in which the forehearth performance had compromised production 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 outgoing forehearth manager or operator passes his knowledge onto his successor. This approach often ensures that any existing bad practice is perpetuated to the next generation with the new operator rarely doubting the wisdom of what he is told.

The primary source of forehearth training is that provided by the forehearth supplier immediately after system commissioning.

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, how to enter PID values etc. Unfortunately it seldom equips the operator with the knowledge of what the best set point profile should be for his glass colour, tonnage and forehearth dimensions. Nor does it enable him to intuitively recognise a combustion fault based on the characteristic response from the temperature sensors or other diagnostic data. Neither does it provide him with the ability to analyse and test the control loop response and ensure the correct PID terms are used.

Modern forehearth systems normally provide a wealth of data which, when correctly interpreted, provide much of the information required to assess the performance status of the forehearth.

However a deeper understanding of forehearth operation can be obtained from testing procedures developed by Forehearth Services to determine factors such as system de-calibration and loop response. It is within this area that the skill levels of many operators are demonstratively inappropriate.

The typical operator response to a change in conditions is to instinctively make an alteration to a set point or an output. If that doesn't work almost immediately then further changes are made. Unnecessary or ill-judged parameter changes to a forehearth system produce disruption to the equilibrium of the forehearth and consequently have an impact on production. Subsequently, a key aim of the Forehearth Training Programme is to enable the operator to use the data available to him via the

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control screen and the forehearth subsystems to identify the exact nature of the problem and its origins. All alterations to forehearth settings should be made based on informed and logical deductions.

An equally important aim of the training programme is to teach the operator how to decide where the change should be made, the scale of the change required and, crucially, the impact of the change and the timescale within which the change will occur. This logical approach to forehearth operation avoids unnecessary production disruption.

Data interpretation

An operator should clearly 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, the calibration of the combustion system and the suitability of the PID values chosen for the loop.

It is crucial the operator knows how to assess the response of the individual forehearth zone control loops.

For example the dead-time (time between making the set-point change and the start of the reaction of the thermocouple to the change) for a thermocouple at a depth of 25mm varies with both glass colour and tonnage. A typical well-calibrated zone, at the correct thermocouple immersion depth in amber glass, should react within two minutes.

Fig. 1 shows a particularly badly responding forehearth zone. Luckily it provides vital clues to the operation of this particular zone. As can be seen from the chart the thermocouple reading was unchanged for a period in excess of 12 minutes. For a 5°C step-change in set-point in amber glass, the zone would be expected to achieve set-point within 12 minutes. As shown by the chart the time required to achieve set-point was 43 minutes. The time required for the glass to flow from the zone entrance to the exit of the zone was approximately 14 minutes based on the zone dimensions and tonnage.

The chart shows that after this period the zone had achieved a 1°C increase in temperature. Consequently, the zone is incapable of responding to any incoming change in temperature larger than 1°C. The implications of this for forehearth control are obvious.

Again the chart provides clues. Firstly, despite the prolonged time away from the required set-point, the increase in heating output over the initial 53 minutes was 7%. This is a clear indication that the PID values are inadequate.

Secondly, an analysis of the combustion system showed that the response was further degraded by both the calibration of the combustion air control valve and the accuracy of the air/gas ratio over the relevant heating output range. Finally a separate analysis chart indicated that an excessive thermocouple immersion depth further compromised the reaction time.

The problems discovered in the zone analysis were subsequently rectified and the zone returned to an acceptable level of operation – assuming the zone had ever been operating at an acceptable level of operation! Take the guessing out of your forehearth operation – have them systematically audited and your operators professionally trained. ■

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