

# Optimising emissions monitoring in glass melting furnaces

Neil Simpson considers how glass producers can optimise emissions using portable gas analysers in glass melting furnaces.



Neil Simpson, consultant at Simpson Combustion & Energy.

## Why did you first decide to use gas analysers?

For the whole of my professional career, I have been using electronic-based gas analysers. I was shown how to use 'Orsat type' chemical instruments but found them unreliable and not that user-friendly. The first instruments I used regularly were to analyse oxygen and CO, which are the most important for safety and combustion efficiency. That is still the case today, however oxides of nitrogen and sulphur are now also important from an emissions perspective.

The first gas analyser that I had with %O<sub>2</sub>, ppm CO, ppm NO, ppm NO<sub>2</sub> and ppm SO<sub>2</sub> was over 25 years ago and although slightly smaller, cost the same as a small family car. As part of a company equipment standardisation, I was actually given this instrument and it still actually works, although it is too old to be used credibly. Thankfully, today's instruments are now less expensive and much more compact.

In 2016, I started working alongside AMETEK Land using the company's Near Infrared Borescope (NIR B) in-furnace thermal imaging system for real-time temperature monitoring inside glass melting furnaces. However, we identified, using AMETEK Land's Lancom 4 gas analyser, that there was a direct correlation between peak flame

intensity and formation of NO<sub>x</sub>. Since it is difficult to ascertain the emissivity of a flame, it is not desirable to state the temperature. Based on the physicist Zeldovich's theory, any parts of a flame that are above 1600°C will form more thermal NO<sub>x</sub>.

## What advice would you give anyone wanting to transport and work with a gas analyser safely?

For the last two years, I have used AMETEK Land's Lancom 4 extensively as part of furnace optimisation for energy and emission reduction projects. When transporting the instrument and specifically when flying, the battery connections should be removed. At a recent glasstec exhibition, AMETEK Land's Lancom operated for eight hours on battery, which is exceptional for any transportable emissions measurement device.

Unless you are working on a low temperature lehr, it is not practical to use the standard stainless steel probe due to the extreme temperatures. For short-term and rapid measurements

over several ports, a consumable ceramic probe is appropriate. If you are working on a glass melting furnace, you should ideally have access to a water-cooled sampling jacket/probe. Otherwise, depending on the glass type, sample location, probe thickness/material and furnace operating conditions, you may consume quite a few probes.

## How do you use the Lancom specifically in your day-to-day work?

Typically, I look at a glass melting furnace when there is a suspected emission or production (pull or quality) issue that could impact revenue. To make comparisons to the medical field, a portable infrared pyrometer like AMETEK Land's Cyclops is like a nurse's thermometer, the Lancom 4 a doctor's stethoscope and the NIR-B Glass a hospital's CT scanner. With the Lancom 4, I check for the breathing (air/exhaust) and the heart (combustion), typically measuring at the regenerator target wall, the port neck and the base of the regenerator, which is a good measure of air leakage. Sometimes I have to climb the chimney stack too!

## What are the considerations when selecting a probe?

When selecting the material, it is worth considering the glass type. Assuming the correct grade, mullite can be a good material due to its high temperature thermal shock resistance. Interestingly, tubes are often manufactured as thermocouple sheaths, which have one sealed end that are cost-effective if you cut it off yourself.

While the Lancom 4 comes with a water catch pot, ▶



AMETEK Land's Lancom4 with probe.

external filter, external dehydrator and an internal flying saucer micro-filter, these should realistically be considered as instrument protection when working on a glass furnace. It is highly recommended that an additional filter system and gas preparation system are utilised. Any additional protection will help extend the life of the analyser and increase its reliability. You want it to work when you need it the most!

At AMETEK Land's factory in Dronfield, UK - and at other locations globally - the company has the ability to calibrate the Lancom 4 utilising calibration or 'span' reference gases. It can also be calibrated on-site if the necessary gases are retained but typically, this is an exception.

### Why is annual calibration necessary?

While an annual calibration is recommended, whenever a stack testing team is on-site there is normally a chance to use their calibration gases to check your instrument. As a 'force majeure', the exhaust from a car can be used as a proof of cell operation for %O<sub>2</sub>, CO and NO<sub>x</sub>.

One of the unusual but beneficial features of the Lancom 4 is the ability to use quick-release hose barbs on the measured inlet and exhaust. It is worth keeping a spare hose barb available in order to let the instrument purge with air between samples. It is probably most important to use this before going out to the furnace following calibration. The barb can be used with a finger to prove suction on the analyser. Depending on the furnace atmosphere and the instrument location, it may be desirable to have a hose connected to the exhaust and vent to a remote area.

In many instruments that I have used previously, the segment was domestic gas heating. When the CO reaches +7000 ppm, the system identifies a potential danger and shuts down the whole instrument. The Lancom 4 typically has a low and high range CO sensor. On furnaces with failing regenerators, I have witnessed CO values in excess of 70,000 ppm.

### What advice can you give on measuring emissions from a furnace?

When working on an oxy-fuelled furnace, it is important to consider that at stoichiometric conditions, there is in theory 66% water vapour. The reality is that it will be less than this but it still has the potential to literally

flood the instrument. When measuring the emissions from an oxy furnace, I advise trying to get as close to the furnace as possible, since there can be strange flows in the flue system specifically when more than one port is used. The benefit of oxy-fuel is that conditions are typically steady-state and there is no need to wait for a full firing cycle on a regenerative furnace. The exhaust port is typically negative pressure, so it is important to seal the probe with fibre to reduce parasitic air.

When working on an end-fired furnace, the port neck is the best location from an emissions perspective but is likely to be more difficult to reach from a health and safety perspective due to height and access. The target wall is often used since there are almost always access platforms. This point is close to the potential location of a Lambda or oxygen probe sensor. It is important to remember that these permanent static probes measure oxygen in an atmosphere where the water vapour is still present and that the regenerator oxygen concentration is measured on a wet basis. As a result, in part of the sample conditioning, the oxygen in a Lancom 4 is a % dry basis. The reversal period is usually 20 minutes and there are typically transient variations as the fuel flow and air ratio stabilises, which then leads to a reduction in air preheat temperature. Depending on the furnace and control system, you may wish to wait five minutes before recording data or disregard during the analysis.

Cross-fired furnaces typically have three to nine ports to measure, with 20-30 minutes per reversal. This creates a chronological dilemma. If you were to measure every port for 20 minutes as in an end-fired, then it could take up to six hours!

As a first step, it is suggested that an attempt is made to measure every port during one reversal. If you follow this process, it is essential that you test the same ports in the same order, since then you will measure at similar phases of the firing cycle. From a safety and heat exhaustion perspective, I suggest starting at the last port first. This port will typically have the highest excess O<sub>2</sub> and so the measurement will stabilise faster.

Position the analyser mid-way between the sample points and as soon as the measurement is stable, record and move the probe to the next measurement point. Then, move the analyser and ideally briefly retire to a

lower temperature area as a new sample comes through. The length of the tube is a compromise since the shorter the tube, the faster the response time but it means there is more risk of damaging a probe. A longer hose is easier to move but has a slower response. By starting at the furthest point, psychologically you are working 'homewards' to the cool control room and a glass of water!

### Portability and accuracy

Lancom 4 is a portable flue gas analyser that is integrated into a compact battery-powered unit and is able to measure up to eight gases simultaneously with nine separate sensors (high and low CO).

Simple to set up and easy to operate, Lancom 4 enables highly accurate spot and semi-continuous gas testing, adaptable to a wide variety of applications and ensuring a plant maintains full compliance with safety and emissions requirements.

Customisable to specific gas measurements and process stream conditions, a resilient stainless steel probe extracts the gas sample, while advanced real-time processing techniques produce the highly accurate combustion and emissions calculations needed. A ceramic probe is available for high temperature applications such as those in the glass industry.

Lancom 4 is simple to set up and offers low maintenance. It is therefore the ideal choice for industries burning coal, natural gas, oil or biomass, including applications in glass, power generation, hydrocarbon processing, natural gas compressor stations, minerals and industrial boilers.

### Leading global supplier

AMETEK Land is a business unit of AMETEK Inc, a leading global manufacturer of electronic instruments and electromechanical devices. The company designs and manufactures a wide range of instruments for industrial non-contact temperature measurement, combustion efficiency and environmental monitoring. ●

#### About the author:

Neil Simpson is a consultant at Simpson Combustion & Energy

#### Further information:

Simpson Combustion & Energy, Ayton, Border, UK  
tel: +44 7711 206522  
email: neilsimpsonfsgt@btinternet.com  
web: www.linkedin.com/in/neil-simpson-ceng-mei-fsgt-8953046/

AMETEK Land, Dronfield, UK  
tel: +44 1246 417691  
email: land.enquiry@ametech.com  
web: www.ametek-land.com

**GLASSPrint2019**  
CONFERENCE

27-28 NOVEMBER 2019, DÜSSELDORF, GERMANY

SEE PAGES 10-11 FOR EARLY-BIRD DISCOUNT

[www.glassprint.org](http://www.glassprint.org)