Improved HF monitoring in Primary Aluminium Smelters with Laser Gas Detectors

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Primary aluminium smelting generates large amounts of hydrogen fluoride gas (HF). Concerns for worker safety and ambient air quality require that HF be monitored at several locations in smelters. Historically, a variety of methods have been used for HF monitoring. Cassette samplers and wet chemistry techniques, coupled with complex and expensive sampling manifolds have monitored roof-line and scrubber duct HF levels. In recent years, open path infrared detectors have been used in rooflines.

Laser gas detectors are now displacing traditional methods by providing HF data that is more accurate, and with faster response times, in packages that are both simpler and less expensive. Boreal Laser's portable GasFinder has proven very effective for HF emissions studies in pot room roofs, ducts, stacks and at smelter fencelines. Both GasFinder and the multi-channel GasFinderMC are used in permanent installations.

Why laser gas detection?

Laser gas detection has many advantages over other techniques for HF monitoring in primary aluminium smelters:

It is an **optical technique** which works by absorption of infra-red light by HF. It therefore provides a direct measurement of HF, rather than relying on secondary measurements such as F ion concentration. A very important additional benefit is that HF can be measured *in-situ*. This overcomes the uncertainties and errors inherent in sampling systems (especially significant for a very reactive gas like HF).

The laser method is **interference-free -** the line-width of the laser light used is about 1/10th of the width of the single HF absorption line detected. This absorption line was selected to be well isolated from absorption lines of other atmospheric gases. The laser method therefore does not suffer from absorption interferences, especially from ever present gases like H2O and CO2, that cause problems with standard IR detectors. As a consequence, laser gas detectors can measure over **long ambient paths**, up to 1 km, using low powered lasers that are completely eye-safe.

A laser gas detector provides **real-time HF data** - typical response time is one second. This means that HF levels can be correlated with work processes and practices, making it possible to optimize processes to reduce HF emissions.

The tunable diode lasers (TDLs) used in commercial laser gas detectors are small, solid-state devices that operate at room temperature and have long-term reliability. So, laser gas detectors are essentially **maintenance free**. The laser light from TDLs can be easily split or switched onto several fibres, enabling multiple point measurements with a single laser gas analyzer. This leads to **lower cost per measurement**.

Boreal's GasFinder - a laser gas detector with additional benefits

Boreal Laser's GasFinder HF laser gas detector possesses additional advantages in cost, reliability and ease of use. A patented **"No Phase Adjustment"** detection technique means that no electronic adjustments or special expertise is required to set up a GasFinder. Different path lengths can be measured in quick succession with no modifications.

Another unique Boreal innovation is a **permanent, built-in, stable, HF reference cell**. Combined with a full spectral line scan and ratiometric measurement scheme, the reference cell ensures that:

- There is no span drift.
- GasFinders can be calibrated in the factory, and need no calibration on-site.
- GasFinders are always "locked-on" to the HF absorption line - not another gas.

Boreal Laser currently makes three different versions of HF laser gas detector:

The portable GasFinder (see figure 1) consists of an integrated transmitter/receiver unit and a remote, passive retro-reflector array. The GasFinder is easily aligned with the retro-reflector using a two- axis instrument mount assisted by a telescopic sight and an on-board visible aiming laser. GasFinder can operate with path lengths from 1m to 1000m. GasFinder is battery operated, weighs less than 5kg and takes less than 5 minutes to set up and start measuring HF.

GasFinderFC is a portable fibre-coupled version of GasFinder with all the same benefits. It can be used for open path, process or stack monitoring. A primary application has been portable stack and duct monitoring.

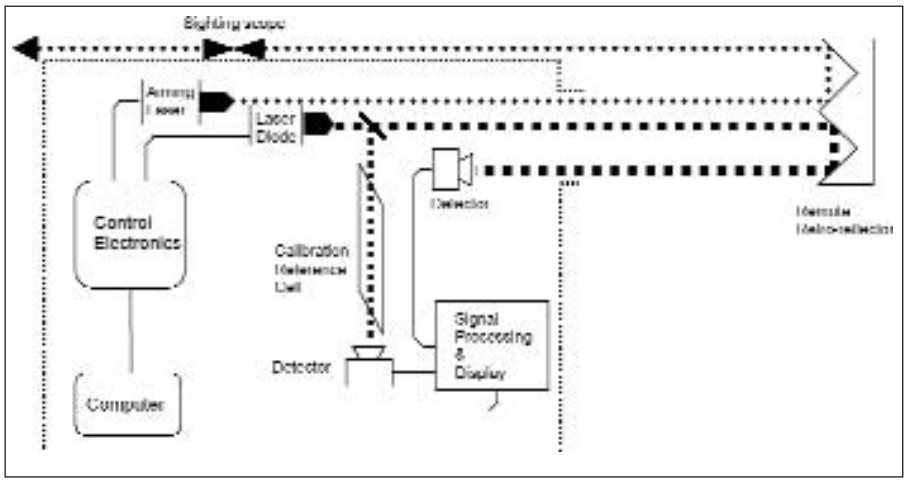

Figure 1 - Schematic diagram of GasFinder.

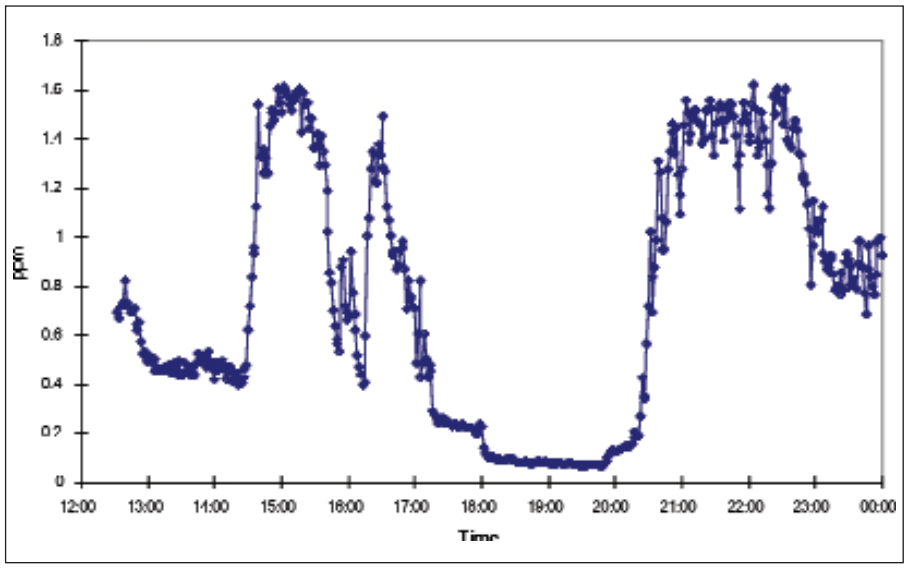

Figure 2: Typical variation in HF concentration in a pot room roof. From 14:20 to 16:35 anodes were being changed; a work break at 16:00 can easily be seen.

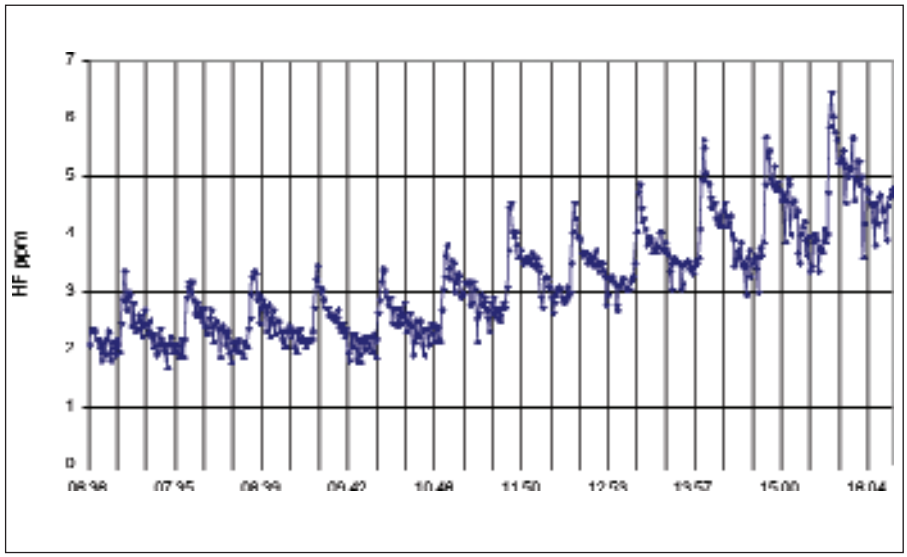

Figure 3: Continuous HF emissions monitoring on an HF scrubber stack. Short term variations caused by changes in scrubber operating conditions are readily identified.

GasFinderMC is a multiple channel version that provides up to 8 independent measurement paths. Fibre-optic cable carries laser light from a central control unit to remote transmitter/receiver heads. Different configurations of open path and duct transmitter heads are available for use with the GasFinder-FC and GasFinderMC systems.

How is GasFinder used in smelters?

1. Pot room roof monitoring

Pot room monitoring used to mean labour intensive cassette sampling along a section of a roof vent. A GasFinder path may be set up along the entire length of a pot room, just below the roof vent, with path integrated HF data continuously transmitted to a central computer. The resulting data enable smelters to better manage pot operations to minimise HF emissions (see figure 2). The portable GasFinder has been used for measuring HF emission levels directly over short sections of pots in order to identify the phases in the pot room cycle that contribute most to overall emissions. In four separate, detailed comparative studies with major aluminium companies worldwide, GasFinder HF data agreed with standard cassette sampling data to within 5%.

2. HF scrubber inlet, outlet and stack monitoring

HF generated in electrolysis pots is collected and carried via ducts to scrubbers where the HF is removed. Simultaneous measurement of HF concentrations in the inlet ducts and outlet stacks

allows the influence of changes in scrubber process parameters to be studied and confirms that environmental are being met (see figure 3).

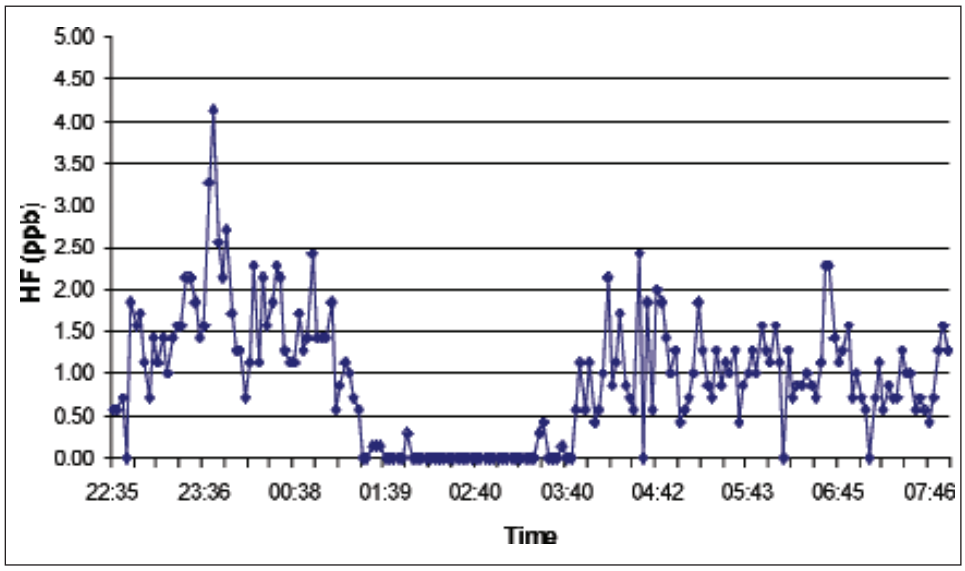

Figure 4: HF concentrations measured over a 1000m fence-line path. Wind was blowing from smelter to fence line except between 1:30 and 3:40.

3. Fence line HF monitoring

There is growing interest from local residents and environmental authorities in the amounts of HF that may be leaving smelters and entering neighbouring communities. The portable GasFinder is ideally suited for the fence-line HF measurements suggested by these concerns.

4. Other applications

- Fugitive emissions studies to identify major sources and implement process changes to reduce HF levels. Some smelters claim 50% reductions in HF emissions as a result of such studies with the portable HF GasFinder.
- Anode shop HF levels. For example, Nordural reported on the use a GasFinder for Anode shop HF monitoring at the 2nd Anode Rodding Conference in Reykjavik in September 2003.
- HF levels inside pot room crane cabs.
- Calibration of other previously installed roof and stack HF monitors.

Boreal Laser HF GasFinder systems are in use in over 30 smelters in 15 countries worldwide. Smelters in North and South America, Europe, Africa, the Middle East, Asia and Australia all now enjoy more accurate and less labour intensive HF monitoring because of the benefits of laser gas detection. **APT**

Biography

Hamish Adam is VP, International Sales and Marketing for Boreal Laser, an Edmonton, Alberta based manufacturer of laser-based gas detectors and analyzers. He holds a B.Sc. in Physics from Aberdeen University and a D.Phil in Atmospheric Physics from Oxford.