

Gasmeter™ in process monitoring applications:

Fluoride Emissions Monitoring in Aluminum Smelters

Process:

Electrolytical reduction of Aluminum from its ores results in emissions of CO₂, CO, SO₂, and HF. During the operation of electrolytic baths an oxygen shortage may occur. This condition, known as an *anode effect*, changes the emissions drastically and leads to emissions of fluorides such as CF₄, CF₃=CF₃, SF₆, and SiF₄ until fresh aluminum ore containing oxygen is added to the process.

Aluminum smelters have to monitor the Sulfur Dioxide and Hydrogen Fluoride emissions, and there are typically emission limit values for these gases tied to the mass of Aluminum produced. In addition, Aluminum plants have greenhouse gas emissions, not only in the form of CO₂ emissions but also CF₄, CF₃=CF₃, and SF₆ emissions during the anode effect situations. While the emitted concentrations of perfluorocarbons and Sulfur Hexafluoride are small, their Global Warming Potential is great. Emitting one kilogram of CF₄ into the atmosphere has the same effect as emissions of 7,000 kilograms of Carbon Dioxide.

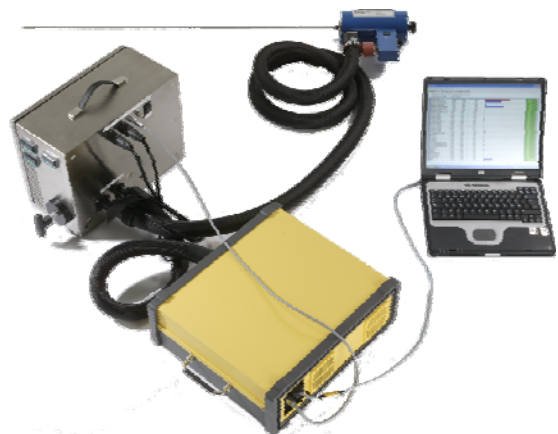
The **Gasmeter** FTIR gas analysers provide accurate analysis of all above mentioned gases both in permanently installed Continuous Emissions Monitoring applications and as portable instruments suitable for short-term measurement campaigns. While the duration of each anode effect can be measured from the process automation control system, the real-time concentration of perfluorocarbons, HF, and SF₆ may be measured continuously with high accuracy using the new In Situ FTIR Gas Analyser. Reporting greenhouse gas emissions based on real measured data instead of estimates ensures that the carbon credits are calculated correctly.

Typical application

Gas		Range	
Water	H ₂ O	0 - 5	%
Carbon Dioxide	CO ₂	0 – 20 000	Mg
Carbon Monoxide	CO	0 – 1000	Mg
Sulfur Dioxide	SO ₂	0 – 400	Mg
Carbonyl Sulfide	COS	0 – 50	Ppm
Hydrogen Fluoride	HF	0 - 15	Mg
Carbon Tetrafluoride	CF ₄	0 – 5	Ppm
Perfluoroethylene	C ₂ F ₂	0 – 5	Ppm
Sulfur Hexafluoride	SF ₆	0 – 5	Ppm
Silicon Tetrafluoride	SiF ₄	0 - 15	ppm

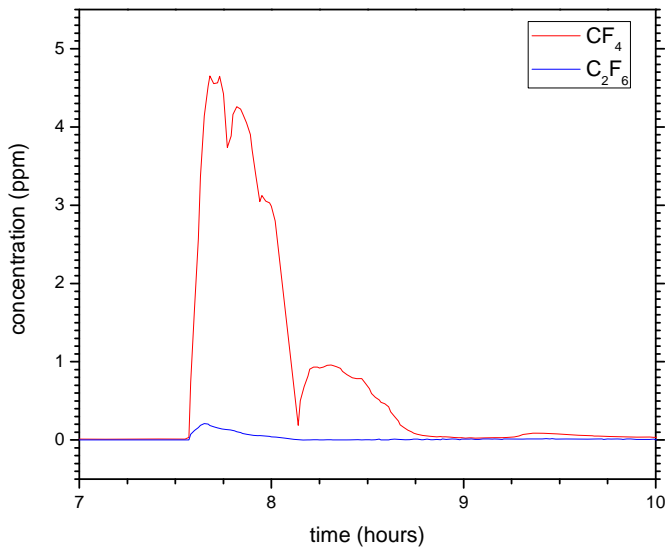
Continuous Emissions Monitoring from Aluminum Smelters is an ideal application for the In Situ FTIR Gas Analyser, which does not need extractive sample handling equipment (*below left*).

Short term and periodical measurements can be carried out with the portable analyzer and sampling system (*below*)



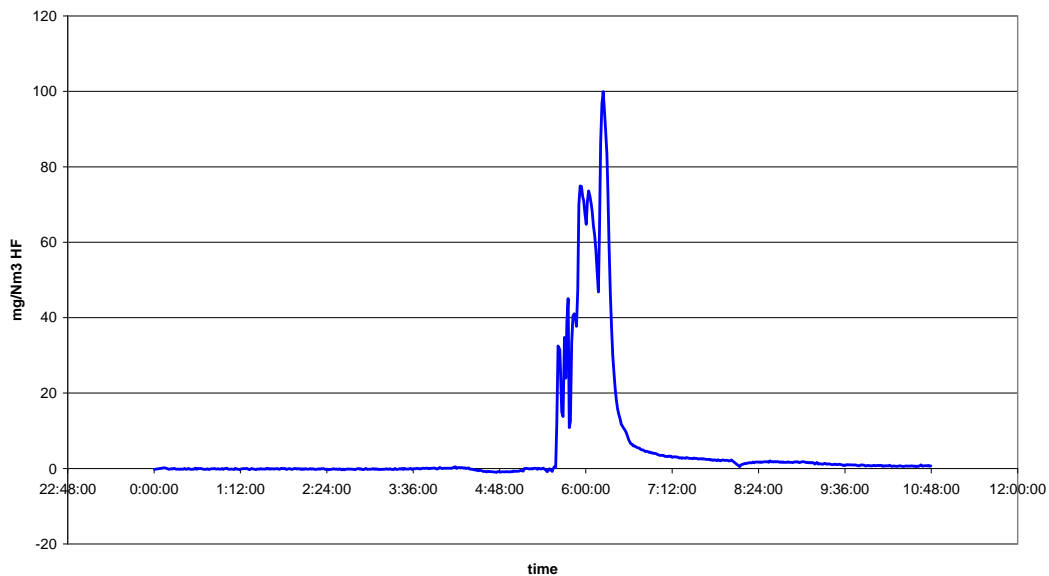
Case Study I: In Situ FTIR Emissions Monitoring at ALUAR in Puerto Madryn, Argentina

ALUAR Installed a **Gasmeter** In Situ FTIR Gas Analyzer for their new production line in 2007. The graph below highlights the emissions during an anode effect condition. Both carbon tetrafluoride and perfluoroethylene concentrations rise measurably and in correlation with the anode effect detected from process data.



During a ventilation fan interruption, the flow was reduced and concentrations of gases increased momentarily. In order to calculate the mass emissions correctly, the instruments must on one hand measure low concentrations in large flow accurately, but on the other hand they have to possess a large dynamical range to allow for the high concentration in low flow situations.

Hydrogen fluoride HF



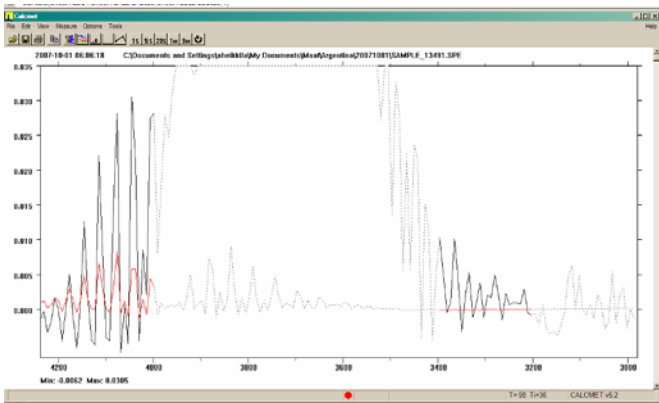


Figure 3. FTIR spectrum from the period when fan was stopped and HF is high. Black trace = sample spectrum, red trace = HF reference. There is no doubt about the presence of HF in this sample.

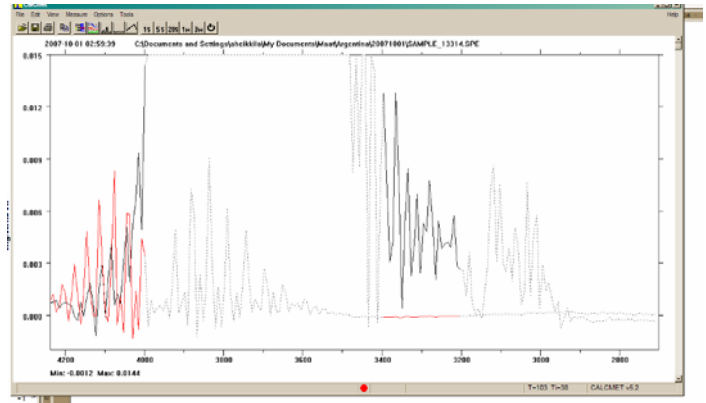


Figure 4. FTIR spectrum from the period before fan stoppage (HF = -0.16 mg/Nm³). Black trace = sample spectrum, red trace = HF reference. The absorption lines in black spectrum do not match with HF reference and are due to water vapour.

A permanently installed on-line FTIR analyser provides accurate readings of hydrogen fluoride (HF) and sulfur dioxide (SO₂) concentrations, and gives an independent reading for the PFC emissions from anode effects.

Case Study II: Portable FTIR Emissions Monitoring by International Aluminum Institute

The International Aluminum Institute (Dr. Jerry Marks, marks@world-aluminium.org) have used a portable Gasmeter DX4000 series FTIR analyser at several aluminum plants in e.g. Dubai, United Arab Emirates and Krasnoyarsk, Russia. The main objective of portable monitoring instruments is to establish the Intergovernmental Panel on Climate Change (IPCC) coefficients between anode effects and PFC emissions. These coefficients are used in the IPCC tier 3 method for estimating the total PFC emissions and the resulting global warming potential of primary aluminum production. See attached article (Marks et al, Light Metals 2004) for more details.



Case Study III: HCl emissions in aluminum casting

In a US Department of Energy funded project carried out at Reynolds Metals Company, the Gasmeter DX4000 was used to measure HCl emissions from aluminum casting when a flux gas containing 5% Cl₂ in Argon was passed through the furnace containing molten aluminum. The instrument was configured to measure the following gases on a continuous basis:

HCl	0 ... 500 ppm
CO	0 ... 10 000 ppm
CO ₂	0 ... 20 vol-%
SO ₂	0 ... 2000 ppm
NO	0 ... 2000 ppm
NO ₂	0 ... 100 ppm
N ₂ O	0 ... 100 ppm
H ₂ O	0 ... 20 vol-%

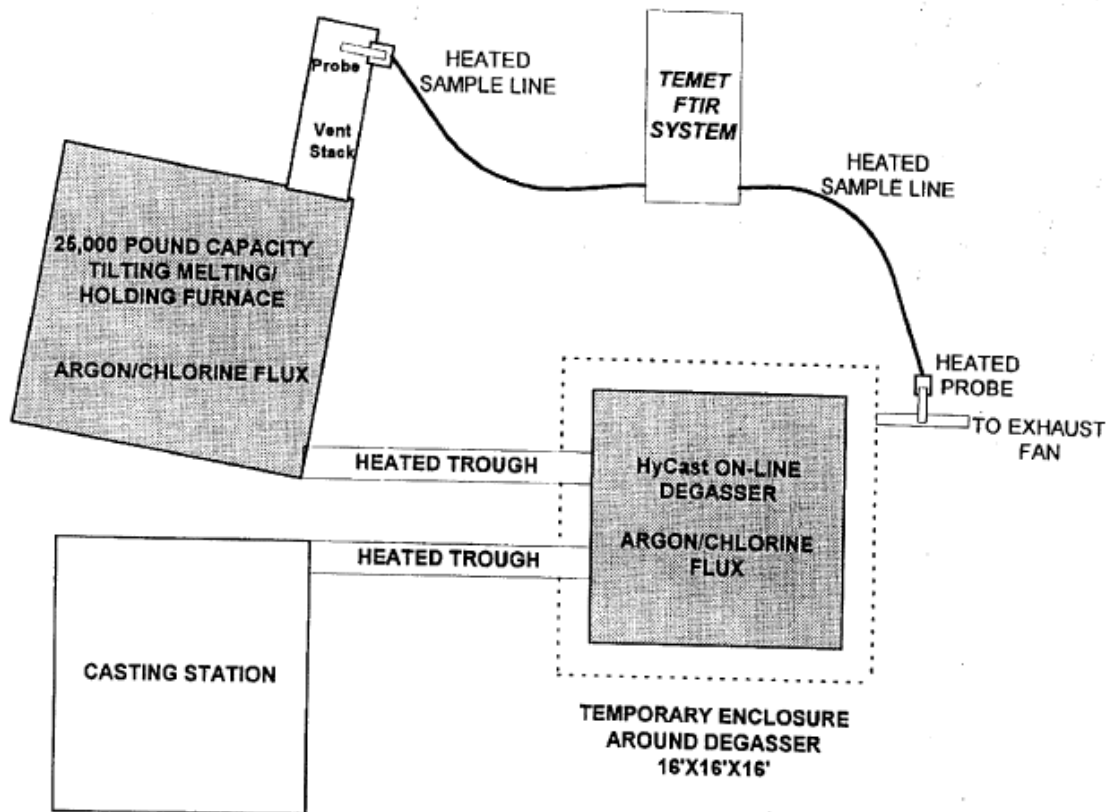


Figure 1: Schematic of Pilot Scale Casting Facility and FTIR Monitoring System