Increasing Efficiency and Safety of Aluminium Smelters

In-situ Laser Gas Analyzer LDS 6 Monitors HF in Real-time

Case Study · January 2005

Energy consumption in aluminium smelters

The basis for all modern primary aluminium smelting plants is the same: Aluminium oxide (Alumina) is dissolved in an electrolytic bath of molten cryolite (sodium aluminium fluoride) within a large carbon or graphite lined steel container known as a "pot". An electric current is passed through the electrolyte at low voltage, but very high current, typically 150,000 amperes. Molten aluminium is deposited at the bottom of the pot and is siphoned off periodically. A typical aluminium smelter consists of around 300 pots.

A basic focus in the Aluminium producing industry is the high energy consumption. Design and process improvements have progressively reduced energy consumption, but have also strengthen the demand for HF control in the flue gas filter and the exhaust gas to protect workers and ambient air quality.

metals INDUSTRY

Continuous monitoring of the HF concentration in aluminium smelters is a key issue for the optimization of the aluminium production process.

The in-situ measuring principle is best suited for this task because it provides the plant operator with measuring data in real-time for fast reaction.

The **LDS 6 In-situ Laser Gas Analyzer** offers best possible capabilities for this application. It can be installed directly at the filter and in the pot room and delivers fast and accurate HF concentration data.

This Case Study presents details of this application.

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Reduction of energy consumption requires HF monitoring

Application tasks

One basic focus in the Aluminium producing industry is the demand to reduce the required energy. Therefore, fluorine-containing auxiliary material (cryolite) is added to the electrolytic reduction of aluminium oxide. This leads to a reduction of the melting point, but as an unwanted drawback, HF- containing emissions are released.
Most of the HF-containing process gas is re-circulated within the process, but some is carried via ducts to filters where the HF is adsorbed and removed.

Here the **LDS 6** is an valuable instrument to optimize the HF filtering process and to control the remaining emissions.

Optimization of the Filter Process

To minimize the emissions of HF, the flue gases are cleaned in a so-called dry filter. These filters contain aluminium oxide particles, which are adsorbing the HF on their surface. Since the adsorption capabilities are limited, the filter material has to be removed from time to time. Figuring out the best point of time for the removal is crucial for the process optimization: No increased emissions due to exhausted filter absorption capabilities occur and no unnecessary filter refreshment has to be carried out. A quality control of the aluminium oxide helps to save costs: The logistic and maintenance efforts for keeping the filter efficient can be reduced significantly.

Emission Control

HF emissions are very problematic in terms of toxicity and are therefore subdued to numerous regulations. A continuous control of the emitted HF gas is necessary to ensure safety for the workers and the environment. In some cases, the monitoring of the HF emissions can also deliver information about the Al-production process itself.

The analyzer LDS 6

LDS 6 (fig. 1) is a diode laser-based in-situ gas analyzer for measuring specific gas components directly in a process gas stream.

LDS 6 consists of a central unit and up to three pairs of cross duct sensors in a transmitter / receiver configuration. The central unit is separated from the sensors by using fibre optics. Regardless how hostile the environment is, the analyzer can always be placed outside any hazardous areas. Measurements are carried out free of spectral interferences and in real-time enabling pro-activ control of dynamic processes.

Full network connectivity via ethernet allows remote maintenance.

Key features include

- In-situ principle, no gas sampling
- Three measuring points simultaneously
- Temperature up to 1500 °C
- Ex-version available (option)

LDS 6 is designed for fast and non-intrusive measurements in many industrial processes. Measuring components include:

O_2/temp., NH_3/H_2O, HF/H_2O, HCl/H_2O, CO/CO_2,
low ppm H_2O, ...

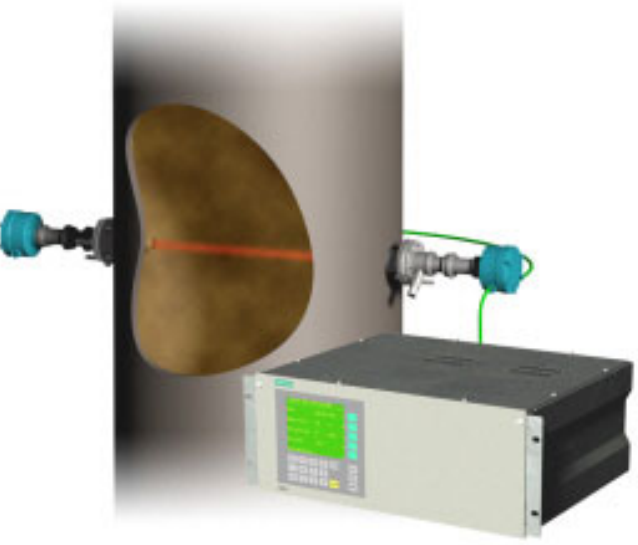

Fig. 1: LDS 6 In-situ laser gas analyzer

Fast and reliable HF monitoring using the LDS 6

Application solution

Filter optimization
The LDS 6 is installed to measure the concentration of HF just before and after the filter (measuring spots 1 and 2). If a significant change in the ratio of HF in raw and filtered gas occurs, a change of filter material is indicated. Exchanges before time are avoided, exchange costs are reduced and filter efficiency is improved.

Emission control
LDS 6 is also capable of controlling the emissions in an open path measurement in the **pot room** (measuring spot 4). As path length, a measurement distance of more than hundred metres can be applied, which leads to truly representative HF concentration data in the ambient air.

The LDS 6 installation behind the filter (spot 2 and 3) also delivers data from the **outlet duct** which ensures that environmental standards are kept.

Up to three measurement spots described above can be controlled with only one LDS 6 central unit, which is connected to the three sensor pairs via fibre optic cables.

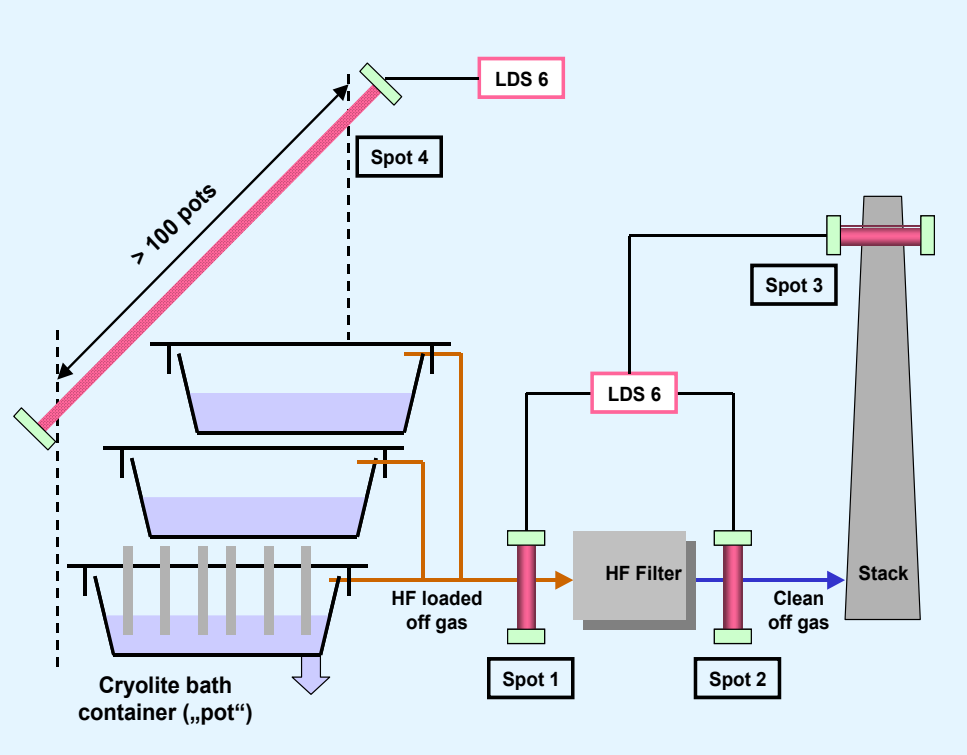

Fig. 2: LDS 6 measuring points in an Aluminium smelter

User benefits

The list of user benefits includes

- Continuous control of filter status
- Minimization of filter operational cost
- Accurate and fast environmental measurements
- Increase of HF safety at work
- Indirect control of the electrolyse process and indication of faulty process conditions

LDS 6 advantages for use in the Aluminium Industry

The design of LDS 6 makes it an ideally adjusted analytical tool for the aluminium industry.

- LDS 6 can measure HF in low and high concentration with high accuracy
- The sensors are designed to withstand very rough industrial environment
- LDS 6 sensors can be operated in strong DC magnetic fields.
- No gas sampling of toxic and aggressive HF is necessary, the measurements are performed in-situ
- Three measuring points are controlled simultaneously with only one instrument
- Highest reliability and lowest cost of ownership: no consumable parts, very low maintenance, no calibration necessary in the field
- All channels measure in real time for high dynamic process control
- No cross interferences due to highly specific single absorption line measurement and dynamic dust load compensation

Case Study

Measuring conditions

Typical measuring conditions for HF monitoring in the aluminium industry are given in table 1.

If the ranges of typical values are kept unchanged, the *application codes* given in the last line of table 1 can be used for ordering the analyzer. In other cases, please use the given contact addresses for technical clarification.

User lists are available for different fields of application. Please contact the addresses below.

HF measuring conditions (LDS 6) in the aluminium industry		
	Filter Optimization	**Emission Monitoring**
Gas to be measured	HF, HF/H_2O	HF, HF/H_2O
HF meas. range before filter HF meas. range after filter	0 - 1000 ppm 0 - 5 ppm	
HF resolution before Filter HF resolution after filter	± 2 ppm ± 0.1 ppm	
HF meas. range in the stack		0 - 5 ppm
HF resolution in the stack		± 0.1 ppm
Option H_2O meas. range H_2O resolution	 0 - 10 Vol.% ± 0.1 Vol.%	 0 - 10 Vol.% ± 0.1 Vol.%
Dust load before filter	< 20 g/Nm^3	
Dust load after filter	< 100 mg/Nm^3	
Dust load in the stack		< 100 mg/Nm^3
Temperature	100 - 200 °C	< 150 °C
Typical opt. path length	1-6 m	1-6 m
Pressure	ambient	ambient
Required response time	approx. 10 s	approx. 30 s
Recommended purging mode	process side only, moderate flow	process side only, moderate flow
Purging media	instrument air, 2-8 bar	instrument air, 2-8 bar
MLFB application code	*GH, HH*	*GA, HA*

Table 1: LDS 6 measuring conditions for HF measurement

If you have any questions, please contact your local sales representative or any of the contact addresses below:

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