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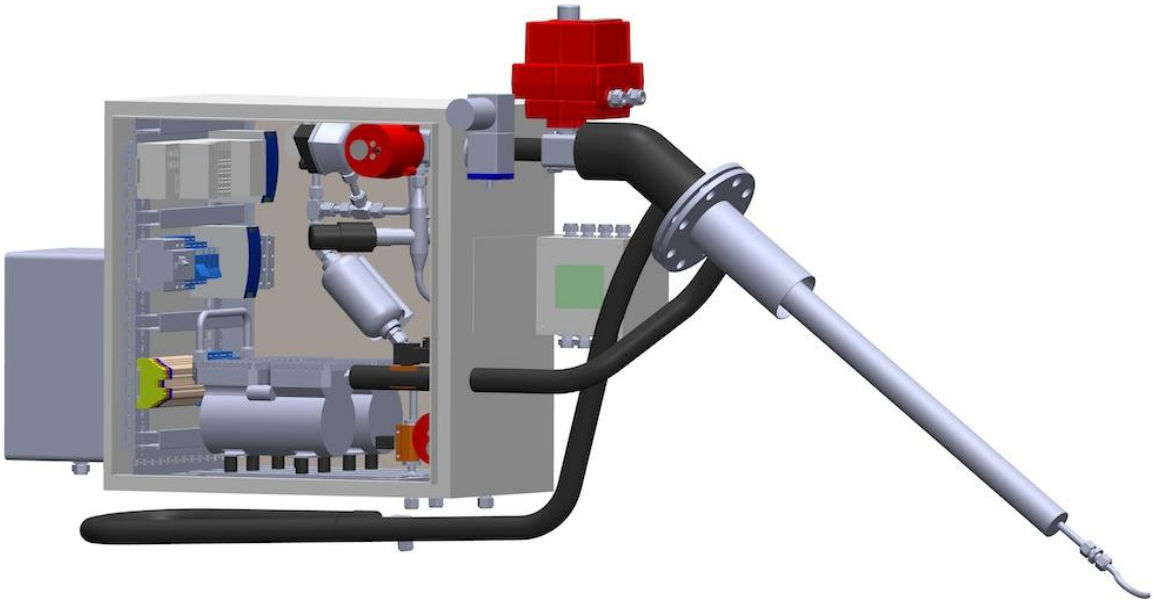
Wet gas extractive dust monitor system MARV 2Ex for Blast Oxygen Furnace STACK applications



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BOF stack monitoring - Application purpose

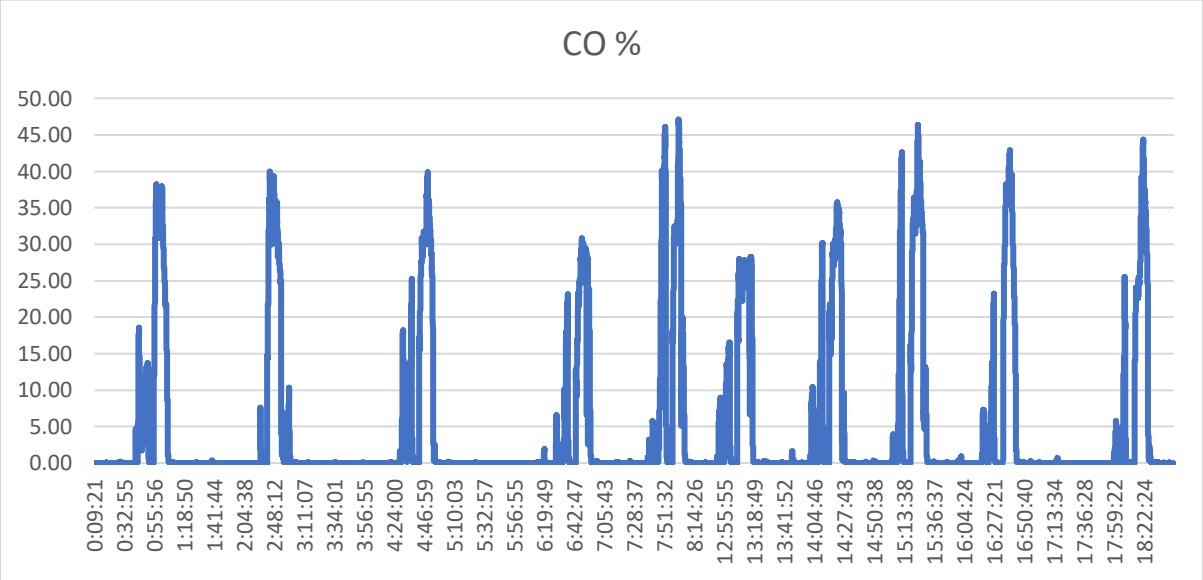
Extractive, Isokinetic and Temperature controlled continuous particulate measurement in metallurgical production with Basic Oxygen Processes – MARV 2EX

BOP, Basic Oxygen Process or Linz-Donawitz (LD) process, is one of main processes in metallurgical production for last 80 years, starting late 1940s. Now BOF, Blast Oxygen Furnaces, produce more then 50% of the world steel. As any other process, the product of the process is not only product itself, metal, but many other "products" – slug and gas exhaust.

With the exhaust gas components, which could be measured with conventional equipment, MARV 2EX dust monitor is the only one, which can measure another one gas component – dust. MARV 2EX is the only one, which measures dust in applications in explosive atmosphere in compliance to ATEX requirements.

Application description

BOP is an intermittent process with metal produced in batches and thus highly fluctuated process parameters. All parameters of the process – temperature, pressure, flow, moisture content, gas composition etc. can change drastically, for example, from 0% volume up to 50-60% volume of CO within a 40-50 minutes of one batch (see pic. 1 and Table 1).



Pic 1. CO concentration in % of volume during the day

Typical composition of the BOF of gas by volume and other process parameters:	
CO – 55 % to 60 %,	Gas temperature: 60 °C (in flue)
CO2 – 12 % to 18 %,	Gas pressure: 0,98 – 1,015 Bar abs
O2 – 0.1 % to 0.3 % and	Gas velocity: 20-35 m/s
balanced with N2.	Relative humidity: 100% (in flue)

Table 1. BOP exhaust gas composition and process parameters

One of the methods for exhaust gas cleaning is wet scrubber. Wet scrubber uses water to absorb the dust, but also makes exhaust gas wet – 100% dew point. There are many other producers, which have Ex-proof dust monitors, but none of them are for wet gas. On the other hand, there are some producers, who has an extractive dust monitor, but none of them can be used in surroundings with explosive atmosphere.

Technical description of MARV 2EX

In order be used in explosive atmospheres, MARV 2EX dust monitor is using special configuration:

- a nitrogen (N2) heated sampling probe,
- a sensor module with N2 purged optics,
- and an integrated PLC based control system, which is housed in a weather-proof powder coated steel enclosure, where a protective gas, N2, maintained at a pressure above that of the external atmosphere is used to guard against the formation of an explosive gas atmosphere.

In a complete installation the probe is inserted in a stack perpendicular to the process flow using a flange. An internal sample pump ejects at the end of the sampling line and draws flue gas through the internal piping of the device and ejects it back into the stack.

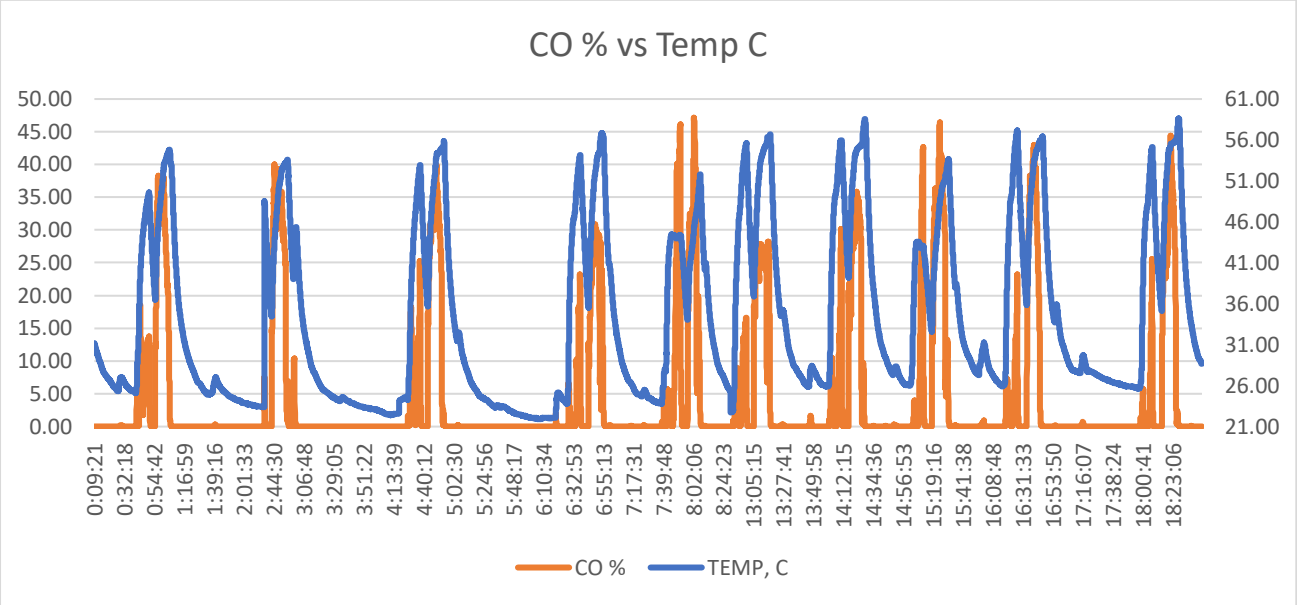
During operation, the probe extracts a gas sample, which is heated by a hot continuous flow of N2 through the probe, to vaporize any moisture in the sample. The remaining dried particles are directed through the measurement chamber of the optical sensor module. Light from an LED is directed through the particle stream, which causes the light to scatter. A scattered light detector captures the scattered light and determines the particle concentration in the gas sample from the amount of scattered light. The underlying method is called “optical forward scattering”.

The device must be calibrated to the process conditions after installation using a standard reference method.

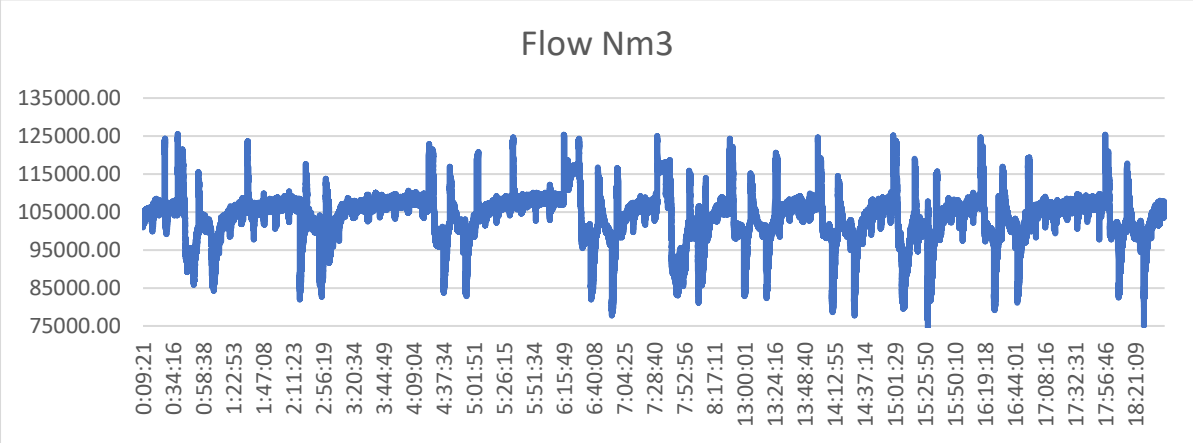
Installation description

MARV 2EX dust monitor was installed on the horizontal part of the exhaust pipe just before the stack flare. Nitrogen with a pressure of 4 Bars goes through the conditioning system, before it is connected to the system.

Main issues of the BO process are high concentration of potentially explosive gas, 100% Dew point, fluctuating temperatures and fluctuating process flow (see Pic 2 and Pic 3)

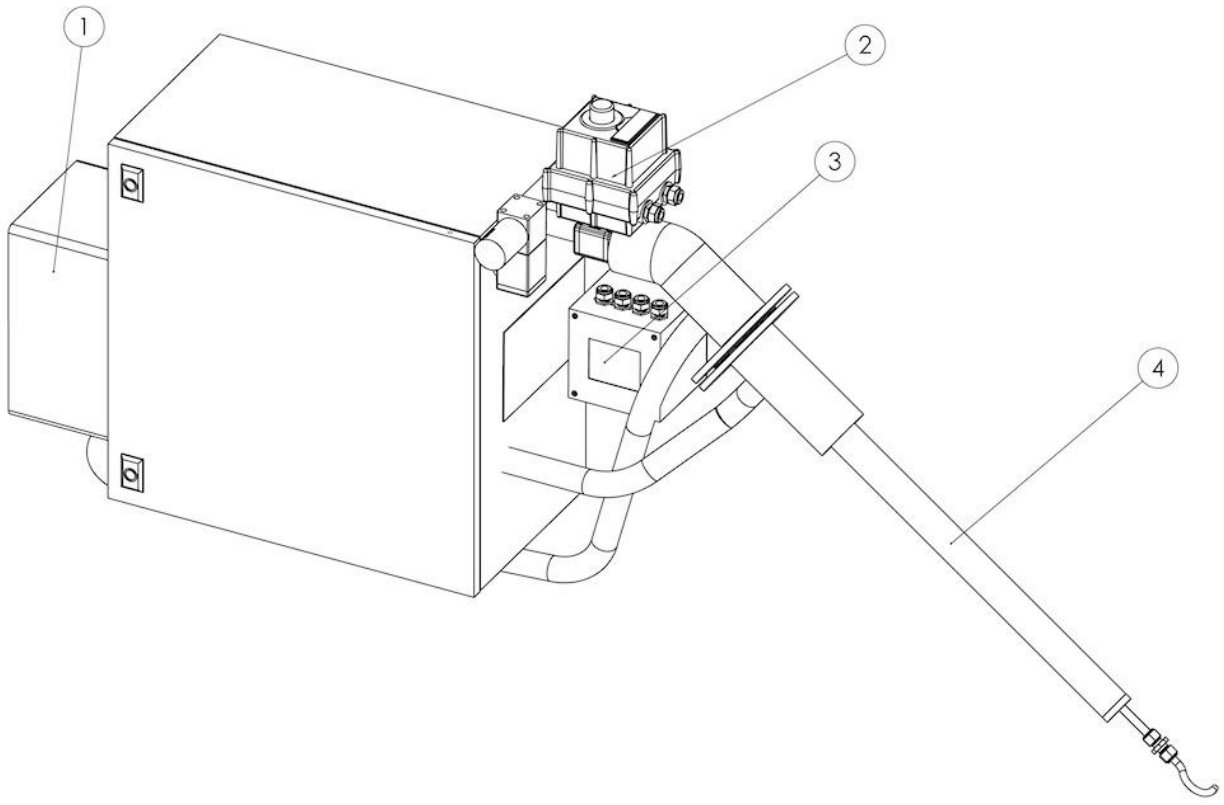


Pic 2. CO concentration in % of volume with Process Temperature during the day



Pic 3. Flow during the day

To overcome an issue with CO/O2 leakage to the enclosure from the sample line and outside atmosphere, we are using high pressure N2 purging system, which continuously maintains pressure inside enclosure above pressure in the sample line and surrounding atmosphere (Pic 4).



①	Ex-proof connection box	③	N2 purge controller
②	Cut off ball valve	④	Sample gas probe

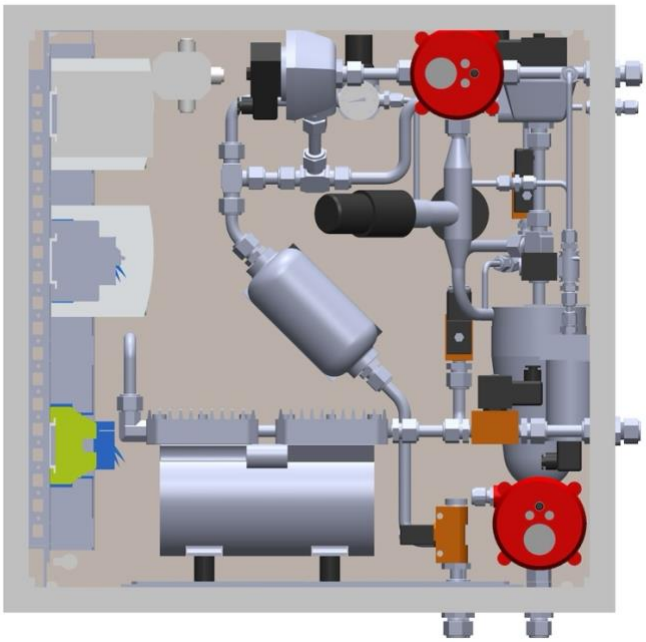
Pic 4. MARV 2EX system overview

The heated probe utilizes N2 for heating, which comes from Zone 1/2, ATEX approved heated lines. It insures, that sucked sample is always heated to the temperatures above water Dew point at all process conditions.

In order to assure correct sampling at different process flows, MARV 2EX maintains the flow of the sample at the levels, that will insure isokinetic sampling at the tip of the probe. For this purpose three steps performed:

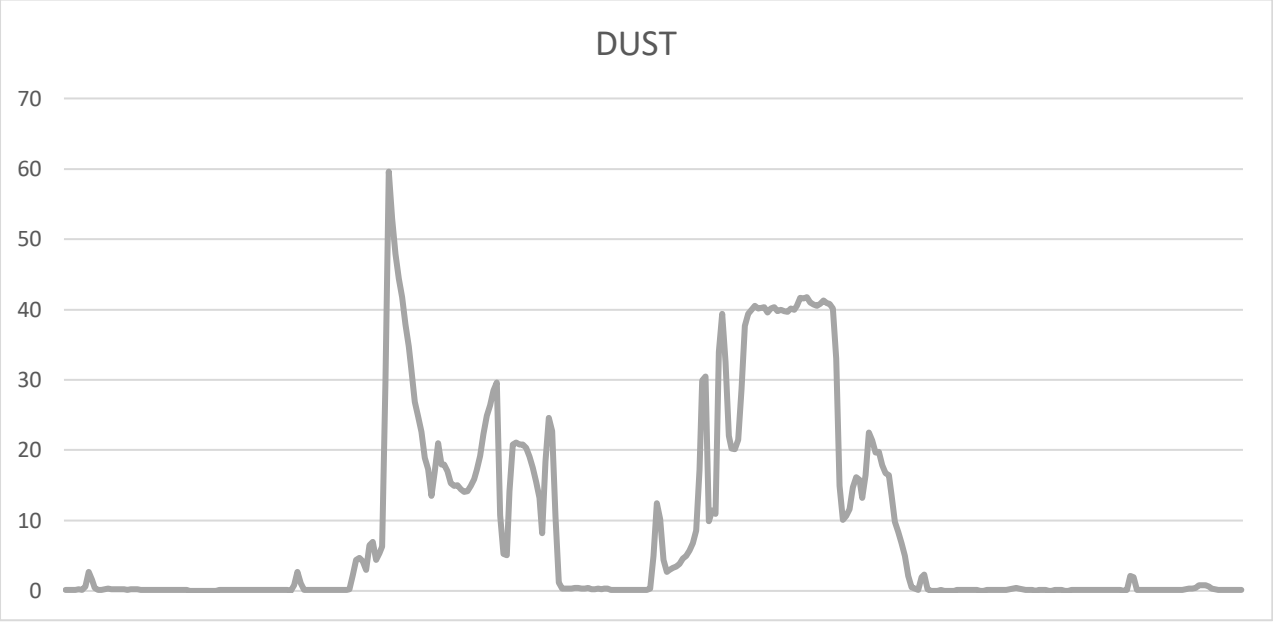
- sample pressure, flow and temperature data are sent to MARV 2EX PLC,
- based on the probe tip diameter PLC calculates the required flow
- precision flow control and regulation system, based on continuous control of the sample flow is monitored with dP sensor and N2 module purge flow regulator, sets the required flow before the optical measurement.

Heated dust filter for pump protection with automatic back purge to insure continuous measurement with no users attention (Pic 5).



Picture 5 – MARV 2EX system inside view

Typical dust concentration levels during one batch (see Pic 6).

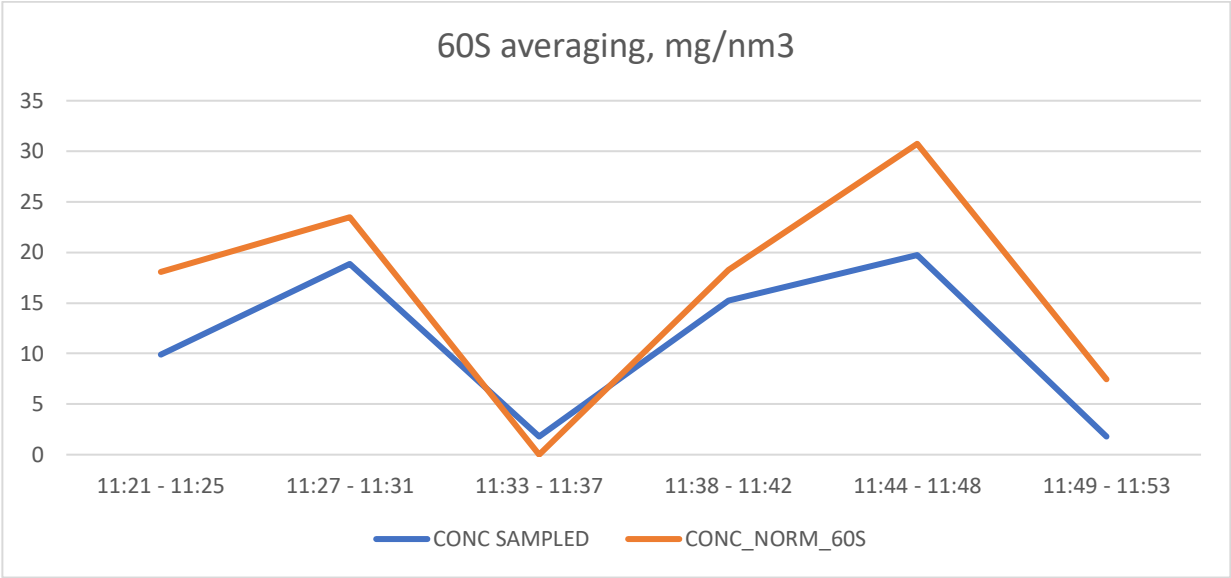


Picture 6 – Dust concentration

System calibration

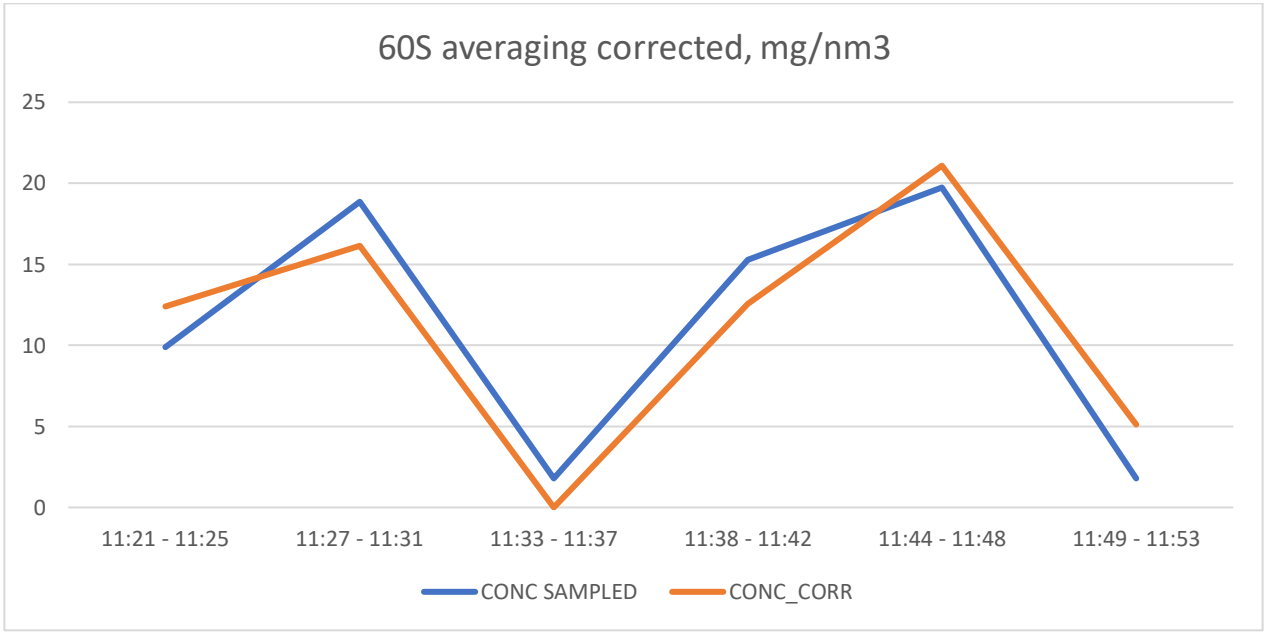
As any other automated monitoring system (AMS) MARV 2EX should be calibrated against standard reference method (SRM). In accordance to EN 13284-2:2004 “Stationary source emissions - Determination of low range mass concentration of dust - Part 2: Automated measuring systems”, the factory set calibration curve of MARV 2EX system was corrected. All values of the AMS system are corrected to normalized values (temperature = 275,15 K and Pressure = 1013 hPa) with the help of on-line measured values of Process Temperature and Pressure.

On Picture 7 you can find the parallel measurements of the MARV 2EX system with the **factory set calibration curve** and graph plotted based on concentrations from SRM. All values are normalized to standard Temperature 275,15 K and pressure 1013 hPa.



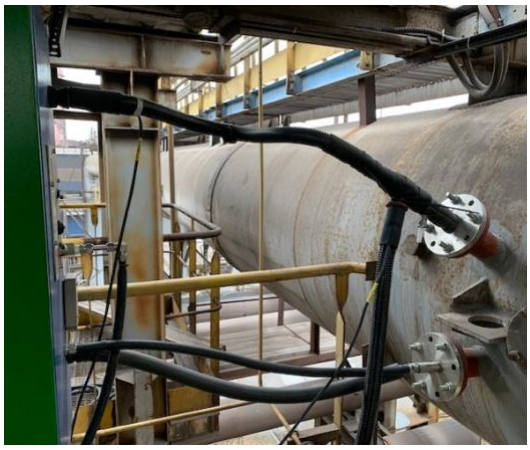
Picture 7. Parallel measurements of the MARV 2EX and SRM. Factory calibration

On Picture 8 are plotted parallel measurements of the MARV 2EX system with the correction coefficient used and concentrations from SRM. All data normalized to standard Temperature 275,15 K and pressure 1013 hPa.



Picture 8. Parallel measurements of the MARV 2EX and SRM. Corrected calibration

MARV 2EX photos



Specification

General information:	
Product name:	MARV 2Ex
Measured objects:	Total suspended particles (TSP)
Measurement principle:	Optical forward scattering
Measurement range:	Detection limit 0.1 mg/m3 Maximum up to 0 - 300 mg/m3
Power consumption:	230 V AC / 16 A, 50 Hz

Input/output signals:	
Input signals (iso-kinetic option):	4 ... 20 mA input (process pressure, temperature, velocity, spare)
Output signals:	Digital output, 24 V DC / 0.5 A (common alarm) Isolated active 4 ... 20 mA output loop (dust concentration), max loop resistance 300 Ohm Ethernet TCP/IP for remote control USB for data logging

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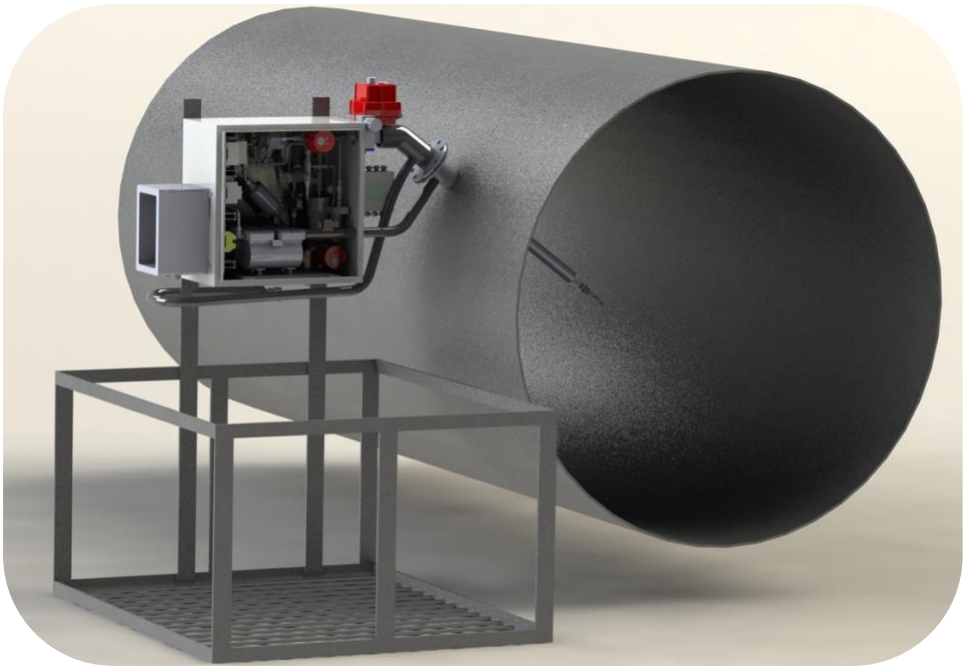
Physical properties:	
Enclosure:	Powder coated steel, IP65
Probe length:	Approx. 1 m (3.28 ft) (depends on application)
Probe material:	Stainless steel (316L)

Process conditions:	
Max. temperature:	200 °C
Flow speed:	5 ... 30 m/s
Pressure:	depends on application

Type of protection from explosive atmosphere:	
According to requirements of IEC 60079-2:	II (1) 2G Ex px IIC T3 Gb II (2) 2G Ex pz IIC T3 Gc

Ambient conditions	
Ambient temperature:	-40 … 60 °C
Humidity:	Up to 95 % RH



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