

Gas emissions of Smart Burners™ technology

The fuel used for the Smart Burners™ system for soil remediation is either propane (C₃H₈), or natural gas (CH₄). After treatment the contaminated vapors are extracted from the soil and led into the flame of the burner. When the generated gases leave the heating tube, they are released into the atmosphere. As this should be an authorized release, **the norms for emission must be respected relating to CO, NO_x, and SO₂**. So the concentrations of these elements must be measured before releasing the gas. These measurements are also useful for regulating the burners for optimal functioning of the system.

The exit gas is measured with a gas-analyzer “MRU VARIO plus Industrial” (see Figure 27). This analyzer makes use of infra-red and electrochemical techniques to **measure up to 9 gas components: NO_x, CO, CO₂, O₂, SO₂ and HCT**. The instrument has also a Pitot tube’ to measure the flow of gas. It is possible with this analyzer to automatically program the measurement at chosen intervals. The analyzer is used for the emission gases going out of the stack, the end of the circuit.



Figure 1 - Gas analyzer (continuous)

The installations are designed, equipped and exploited in such a way that the legal limits of emissions mentioned here are not surpassed, taking into account the methods of measurements mentioned hereafter:

- **Carbon monoxide (CO):** during the functioning of the system, the concentration of CO in the combustion gas **does not exceed the following values:**
 - 50mg/m³ combustion gas in daily average
 - 150 mg/m³ combustion gas in at least 95 % of all measurements matching the average values in 10 minutes or 100 mg/m³ combustion gas of all measurements matching the average values calculated in half an hour during a period of 24 hours.
- **NO_x and SO₂:**

Parameter	Daily average value	Average value on 30 minutes
Sulfur dioxide (SO ₂)	50 mg/Nm ³	200 mg/Nm ³
Nitrogen oxide (NO _x)	500 mg/Nm ³	

Table 1- Value limits for SO₂ and NO_x

The results of the CO, SO₂ and NO_x measurements are reported in normal conditions of temperature and pressure, i.e. 273 K, with a pressure of 101.2 kPa, with 11 % oxygen in the dry gas.

Otherwise, CO is an indicator of incomplete combustion taking place in the soil during the heating. Measuring the quantity of CO in the extracted gas from the soil, (f.i. in the vapor tubes), supports the monitoring of the progress of the decontamination. The concentration of CO will be important at the start of the treatment and will decrease gradually as the pollutant leaves the soil, aspired by the system GTR™. When the level of CO in the aspired gas tends to be zero the depollution can be considered to be complete.

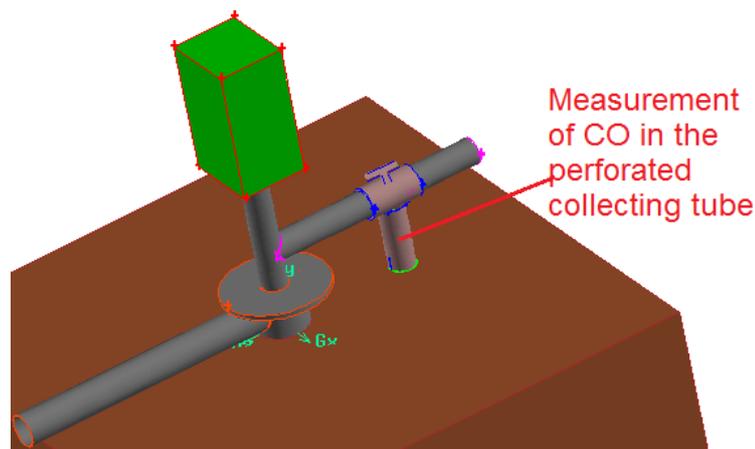


Figure 2 - Measurement of CO in the perforated collecting tube

In order to secure optimal security in and around the operational site, CO, CH₄ and fire detecting instruments are installed, as well as a system for an emergency stop of the system, even on distance.

To determine the debits in the circuit (incoming air in the burners, the heating tubes, the stack, etc.), TPS TECH makes use of a Pitot tube. Placed perpendicularly in the flow, the tube Pitot can measure the dynamic pressure.

$$v = \sqrt{\frac{2p_{dyn}}{\rho}}$$

In which p_{dyn} is the dynamic pressure and ρ the mass volume of gas.



Figure 3 - Measurement of the dynamic pressure of the air entering a burner (with a Pitot tube)