Custom Solution: Low ppb detection of Sulfur hexafluoride (SF_6) by Advanced Ion Mobility Spectrometer - AIMS

The ion mobility spectrometry technique offers advantages like high sensitivity (ppb range), fast response (ms range), compact design, operation in atmospheric pressure and ability to separate the isomeric compounds. In this short report we demonstrate the sensitivity and fast response of IMS for **Sulfur hexafluoride (SF6)**.

Sulfur hexafluoride (SF_6) is an extremely potent and persistent greenhouse gas that is primarily utilized as an electrical insulator and arc suppressant. It is inorganic, colorless, odorless, non-flammable, and non-toxic. SF_6 has an octahedral geometry, consisting of six fluorine atoms attached to a central sulfur atom, molar mass of SF_6 is 146.06 g/mol.

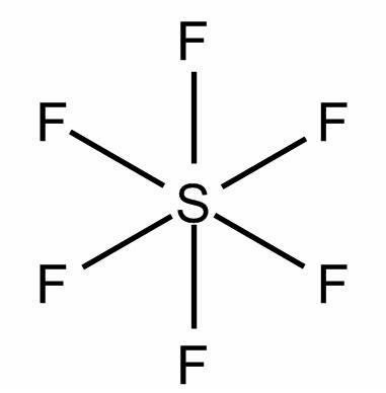

Figure1. SF_6

In this short Laboratory Report we demonstrate the Custom solution of Ion Mobility Spectrometer operated in sub-atmospheric pressure for detection of SF_6 at low ppb level.

Experiment

The **Customized Portable-Advanced Ion Mobility Spectrometer** (**PAIMS**) was used in this experiment. The instrument was interfaced to external battery and together with external sniffing pump (10L of atmospheric air) was placed to Pelican case as we can see on figure 2. The custom made PAIMS for this application works under extreme operating parameters. The parameters of **PAIMS** are listed in Table 1.

Working pressure	**340 mbar**
Working temperature	**120 °C**
Drift Gas	**Zero Air**
Drift gas flow	**300 mL/min**
Drift field intensity	**570 V/cm**
Sample gas flow	**120 mL/min**
Polarity	**Negative**

*Table1. **PAIMS** working parameters*

The *10mL* of SF_6 (purity 99.8) was injected to *10mL* vial with septa. The considered concentration of the SF_6 in vial was 50%.

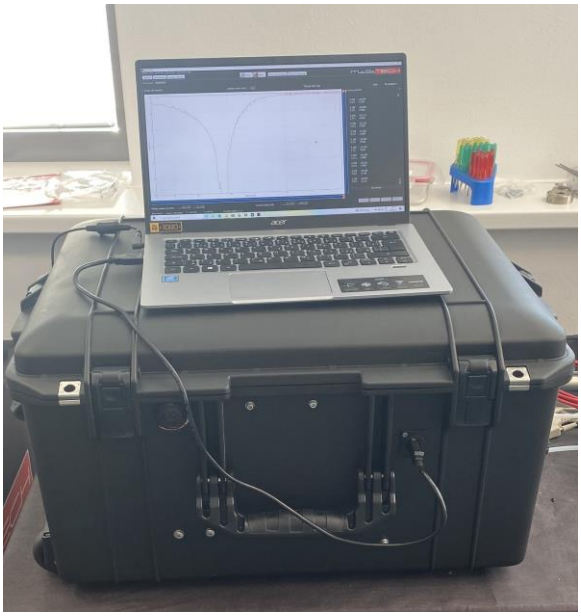

*Figure 2.*P-AIMS integrated to Pelican Case with battery *and external sniffing pump*

Small amount of this mixture (*1-2µL*) was took from vial and diluted with atmospheric air. In next step was 100 µL of sample was injected to sniffing port of instrument. The sniffing speed was 10L/min. The vapor pressure *2.9 MPa* was used for correct calculation of concentration.

Results and discussion

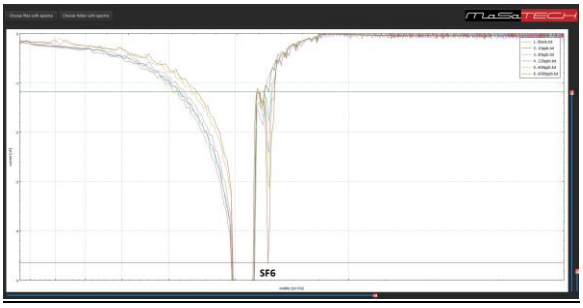

Figure 3. 10, 60,120, 600 and 6000ppb of SF6

The IMS response for 10, 60,120, 600 and 6000ppb of **SF_6** is shown on figure 3. As we can see from this figure, the SF6 results in formation of peak with reduced mobility *1.91cm^2.V^{-1}s^{-1}*. The smallest concentration that was IMS able to detect was ***10 ppb***. The highest concentration we tested was *6000ppb.*

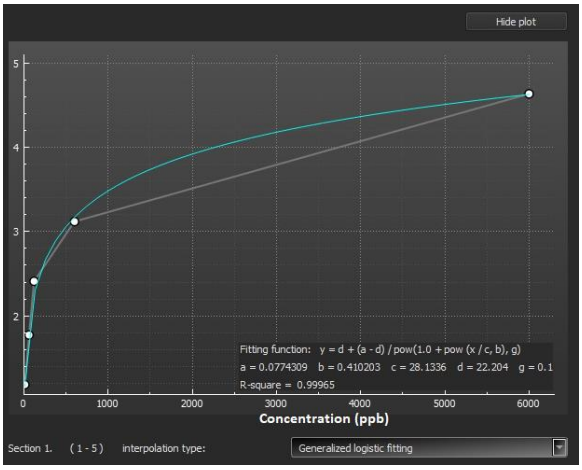

Figure 4. IMS response for different SF6 concentration.

Figure 4 shows calibration plot of IMS response for 10, 60,120, 600 and 6000ppb of SF_6. The MaSa**TECH** software allow calculation of peak **volume**, peak **area,** averaged peak **area** along the monitoring time as well like peak **intensity** and averaged peak **intensity** along the monitoring time. The **SF_6** peak **Intensity** was used in calculation. The *Generalized Logistic Fitting* with *R^2=0.999* was chosen as an optimal for calculation. Considering 3x noise level we reached **limit of detection for SF_6** at value **10 ppb.**

Conclusion

In this short laboratory report we demonstrate the ability of **PAIMS** to detect **SF_6** at low ppb concentration. The **LOD** for **SF_6** was **10ppb.** We are also demonstrating possibility of our Advanced IMS to work under non-standard conditions (320mbar,120 ^{o}C) required for successful detection of SF_6 at low ppb concentration.