

Stability of mercury compounds at high temperatures

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INTRODUCTION

What is the temperature fractionation of different mercury species applicable for?

- to determine the release temperatures of different mercury compounds in solid samples (e.g. coal),
- to develop more efficient mercury removal technologies at high temperatures,
- to understand the complexity of mercury reactions in cement-producing industry.

For developing the method of temperature fractionation, a home-made apparatus was used, in which known mercury compounds, pure or mixed with SiO_2 , were heated by a slow increase of temperature (approximately $2.2 \text{ }^\circ\text{C min}^{-1}$) to $800 \text{ }^\circ\text{C}$ in a flow of either nitrogen or air. Released elemental mercury was detected by an atomic absorption spectrometry technique. The results showed that not only the type of carrier gas, but also the substrate affected the number and size of the peaks and the temperature at which elemental mercury was released.

Method – Pyrolytic technique:

- Measuring apparatus: Lumex Pyro RA-915+ detection by cold vapour atomic absorption spectrometer (CVAAS) with Zeeman background correction,
- Temperature range: From room temperature to $800 \text{ }^\circ\text{C}$,
- Heating rate: $\sim 2.2 \text{ }^\circ\text{C min}^{-1}$,
- Carrier gas: Nitrogen or Air,
- Gas flow rate: 1 L min^{-1} ,

Sample:

- 9 mercury substances were used (Hg_2Cl_2 , HgCl_2 , HgS , Hg_2SO_4 , HgSO_4 , HgF_2 , HgSe , HgO-red and HgO-yellow),
- Pure compounds,
- Compounds mixed with SiO_2 powder,
- Sample mass: 9 – 30 mg.

Fig. 1: HgS, pure and mixed with substrate in nitrogen

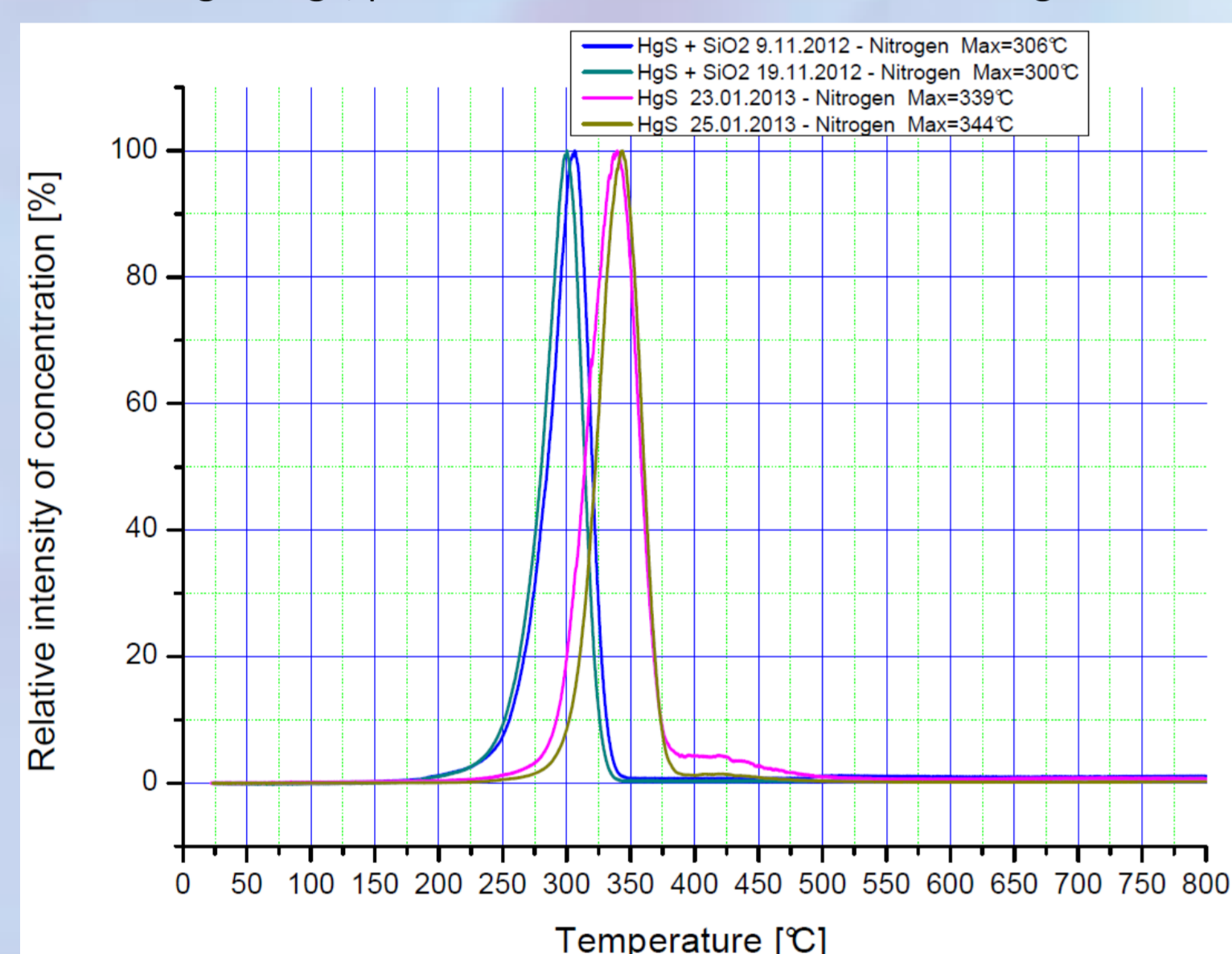


Fig. 2: HgF₂ pure and mixed with substrate in nitrogen

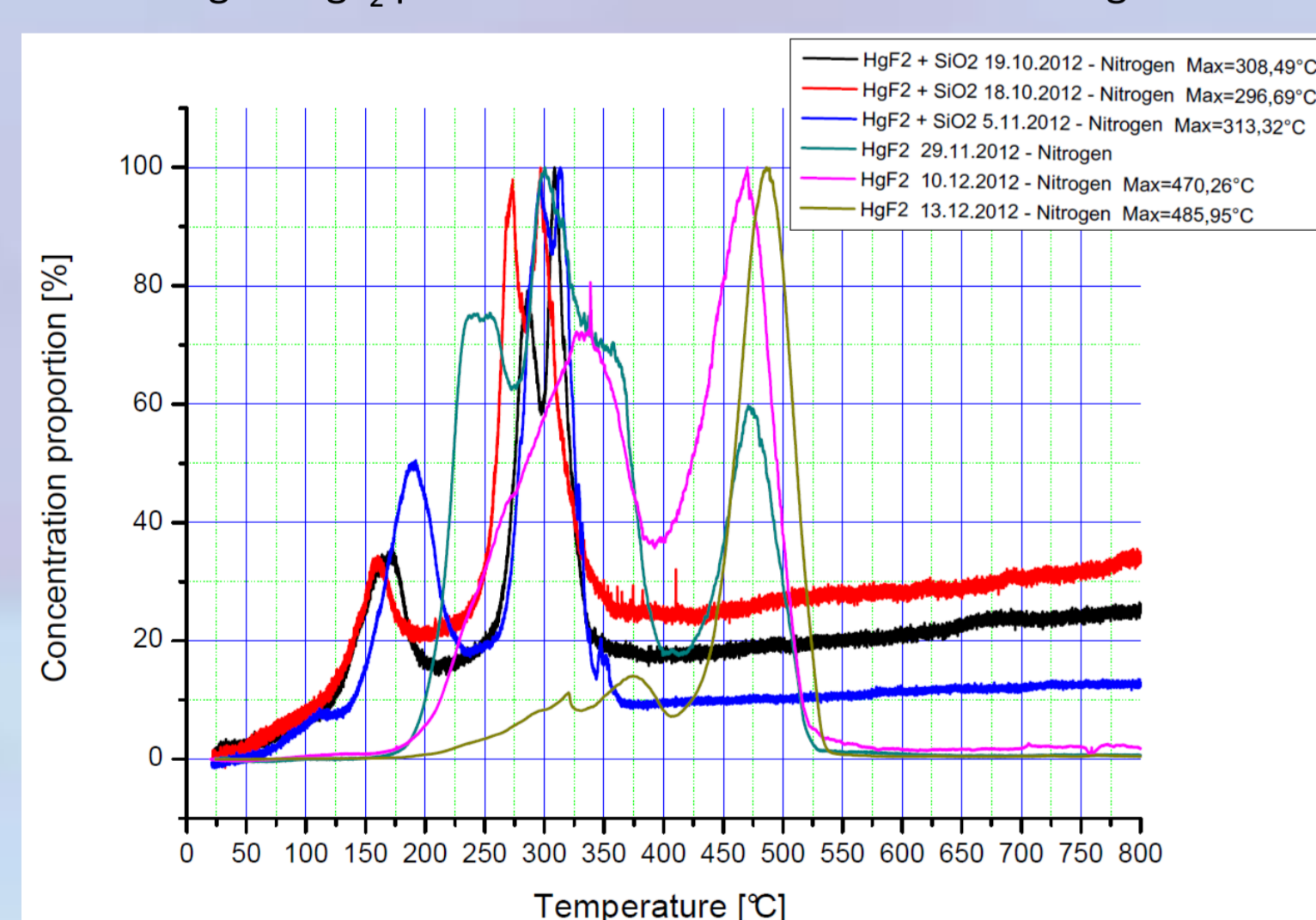


Fig. 4: HgSe pure and mixed with substrate in air

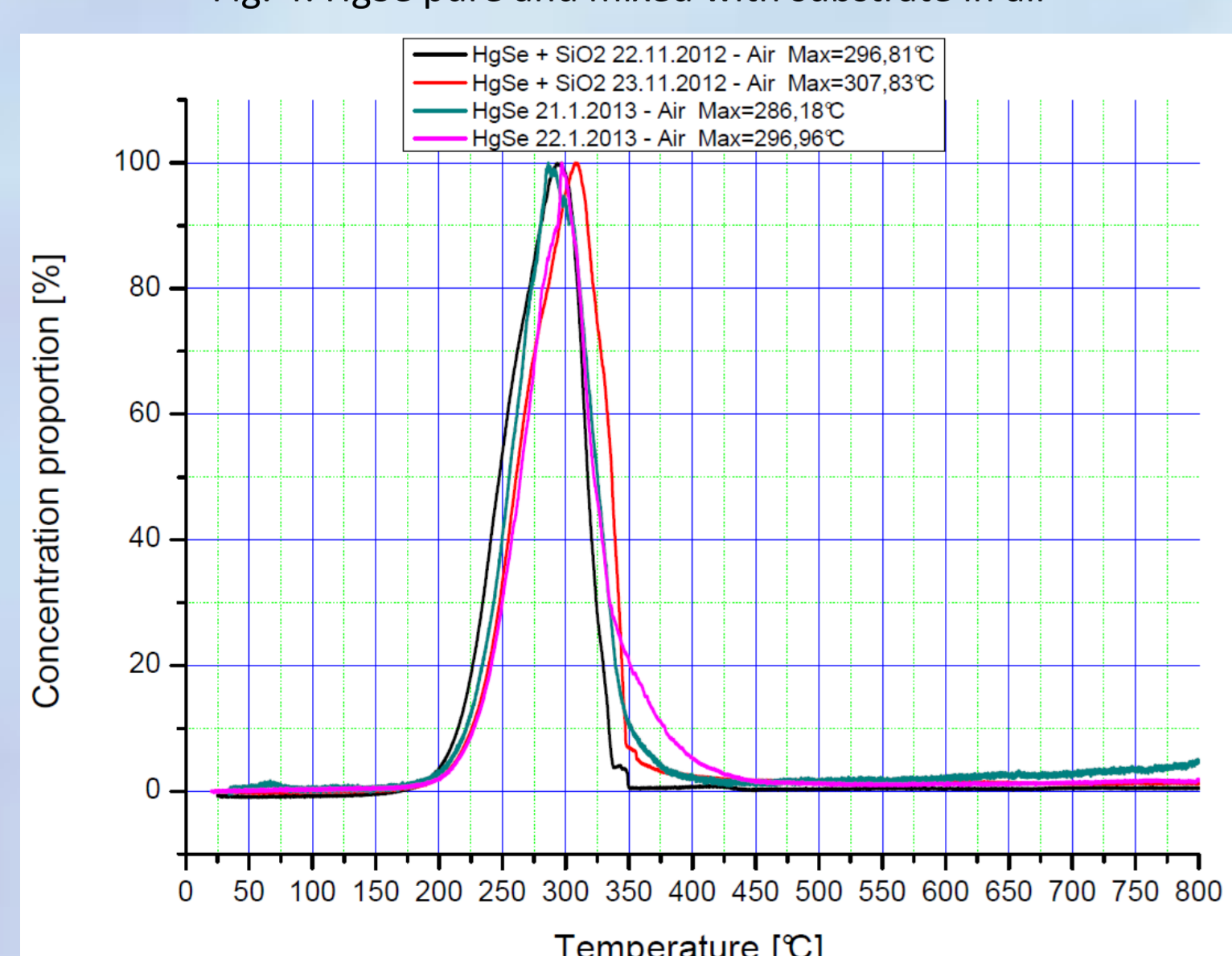
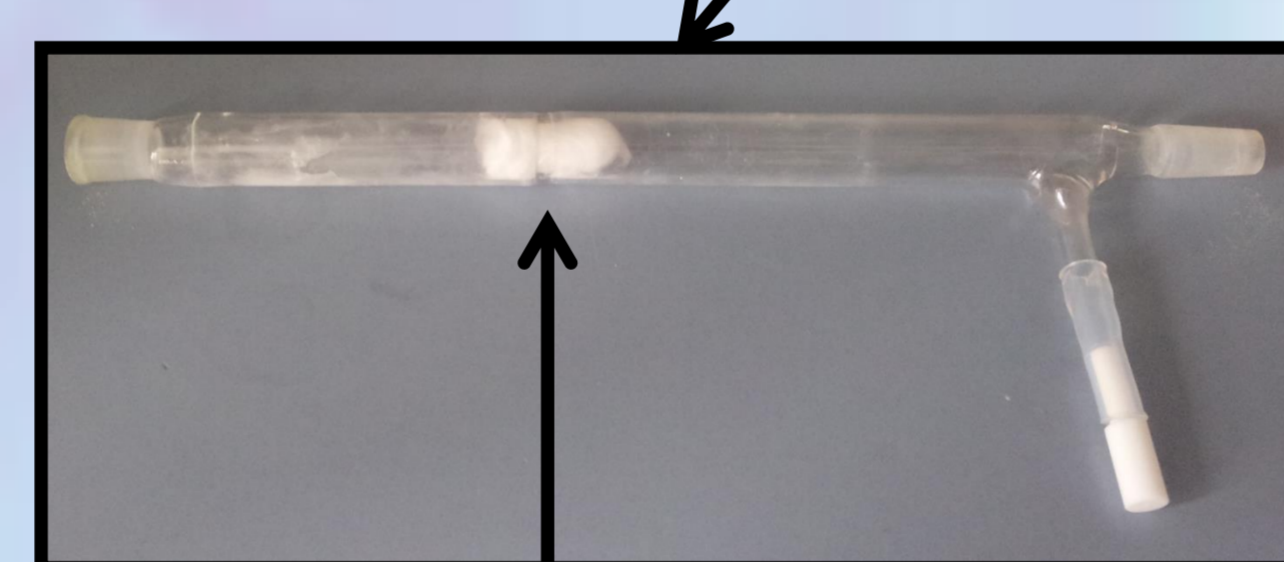
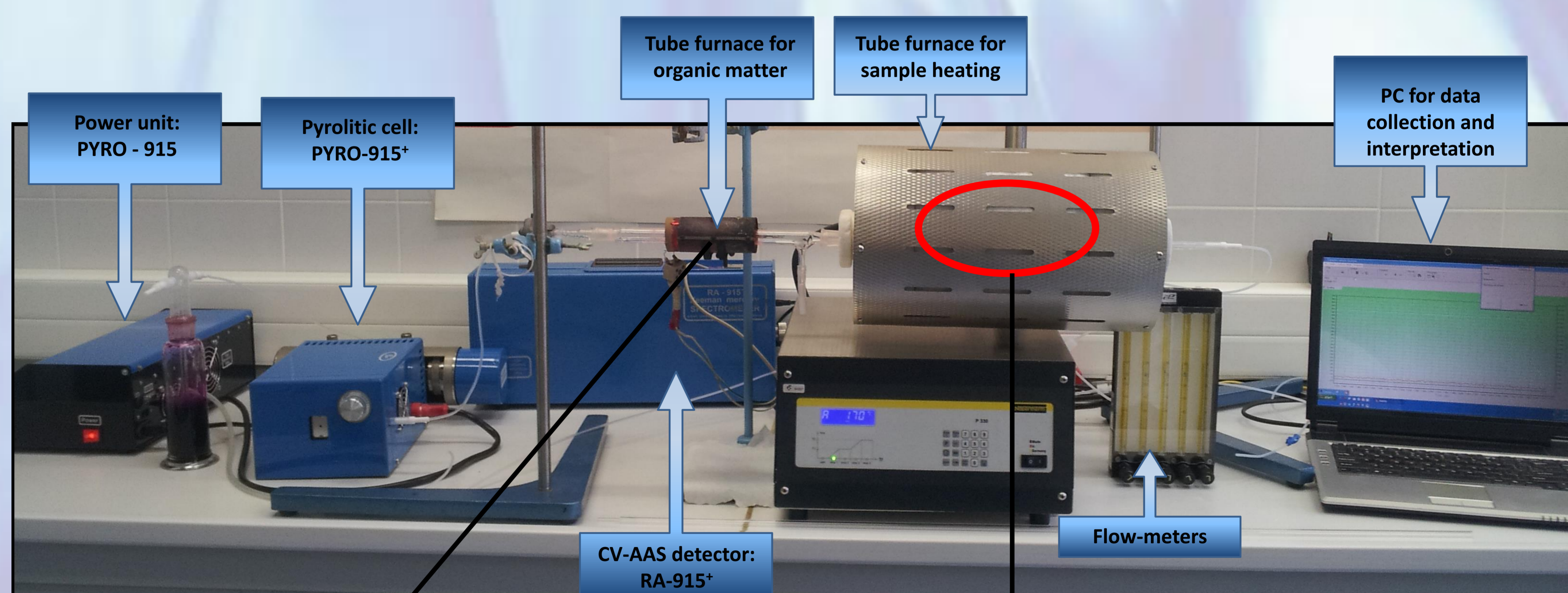
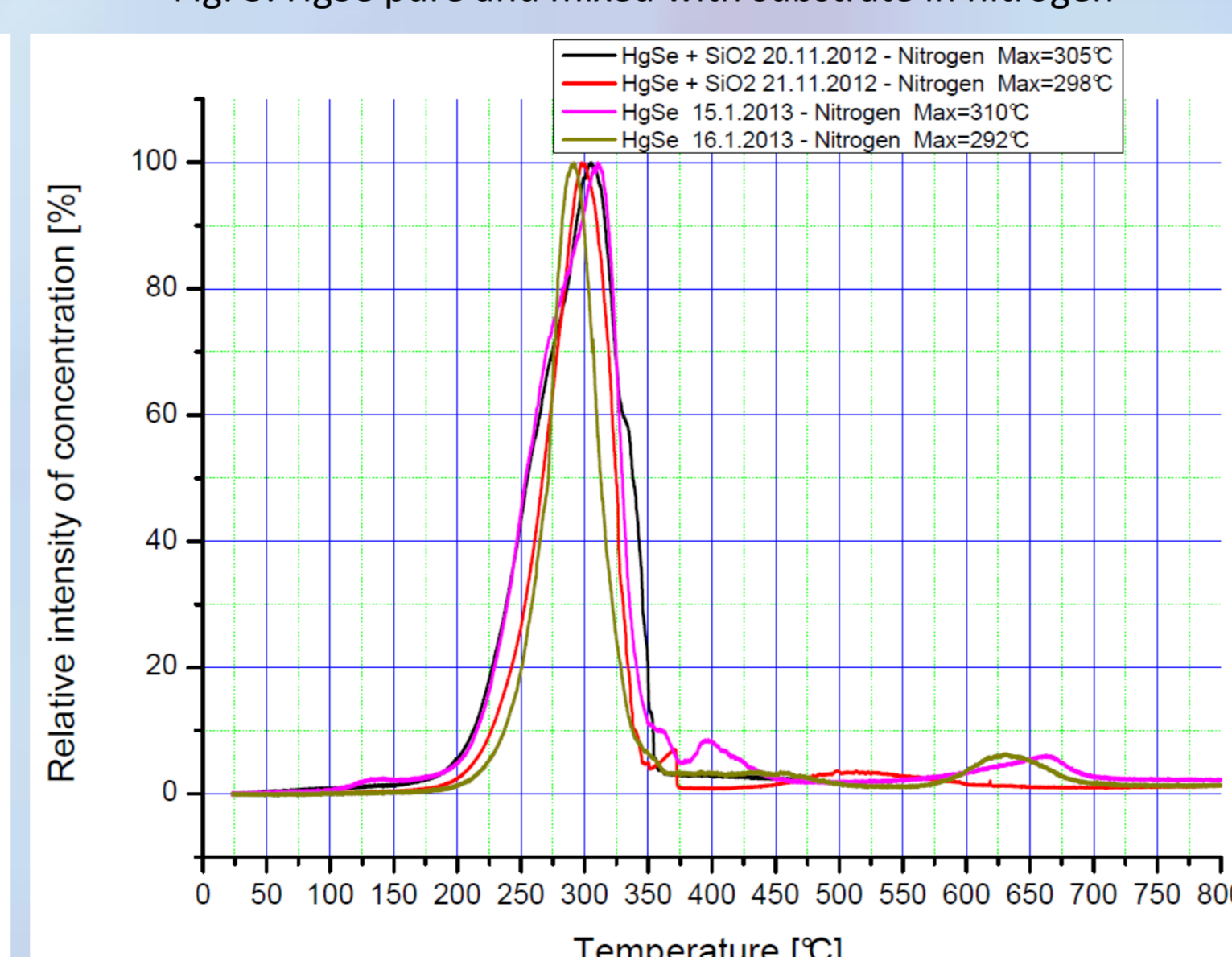
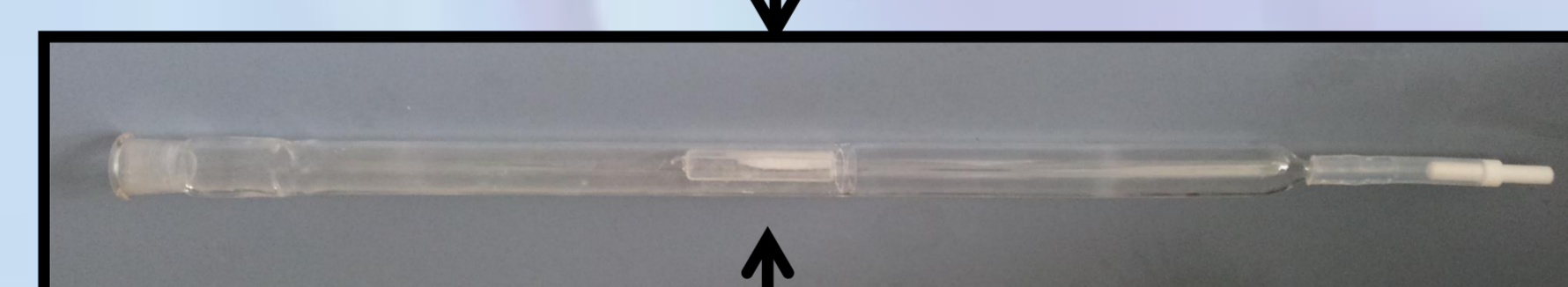


Fig. 3: HgSe pure and mixed with substrate in nitrogen



Inside of quartz tube quartz wool filter for organic matter can be seen



Inside of quartz tube quartz boat with sample can be seen

Results:

- Thermograms with one peak: HgS , Hg_2Cl_2 , HgCl_2 , HgO-red and HgO-yellow (Fig. 1),
- Thermograms with multiple peaks: HgF_2 , Hg_2SO_4 and HgSO_4 (Fig. 2),
- Thermogram of HgSO_4 is a single peak compound when used as a pure substance, but shows multiple peaks, when it is mixed with substrate SiO_2 ,
- Carrier gas effects the number of peaks and the temperature at which maximums occur,
- Substrate effects the mercury release for all compounds except for HgSe (Fig. 3, 4),
- The achieved repeatability of the maximum peak is below 15 degrees range.

References:

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- G. Luo, et al.. Identifying modes of occurrence of mercury in coal by temperature programmed pyrolysis. Proceedings of the Combustion Institute, 33:2763–2769, 2011,
- M. A. Lopez-Anton, et al.. Analysis of mercury species present during coal combustion by thermal desorption. Fuel, 89:629–634, 2010.

Future work:

- Other substrates will be used such as: CaSO_4 , Al_2O_3 , charcoal and coal.
- Other pure mercury compounds as well as mixtures of them will be examined.