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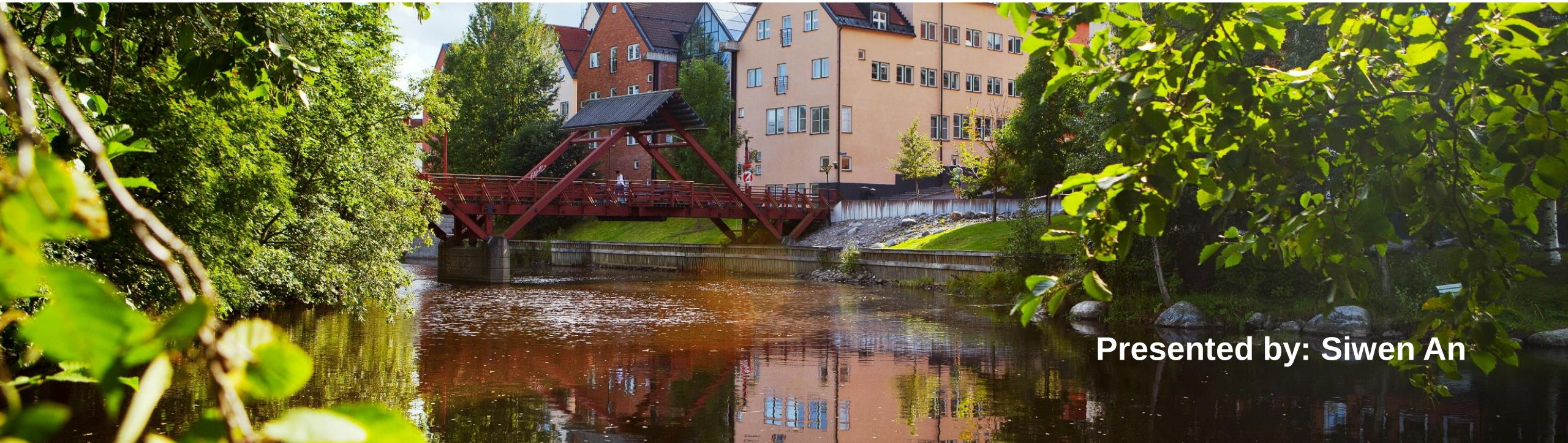
Comparison of Elemental Analysis Techniques for Fly Ash from Municipal Solid Waste Incineration using X-rays and Electron Beams



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Project Goal

- In this paper, the purpose is to compare two methods to analyze the elemental composition of a random group of fly ash samples:

  (1) A scanning electron microscope with energy dispersive spectroscopy using electron beams (**SEM-EDS**).

  (2) An X-ray spectrometer using X-rays to irradiate the samples (**XRF**).

- Compare the difference of fly ash samples before and after the stabilizing wash process (**Washed ash and unwashed ash**).

- Metals of interest for monitoring of the washing process are Sodium(Na), Potassium(P), Chloride(Cl) and Sulfate(S).

Municipal Solid Waste Incineration

- To manage non-recyclable garbage and utilize the energy from garbage.
- Incineration produces fly ash along with flue gas and heat. Fly ash contains several hazardous metals and must be safely disposed.
- Korstaverket in Sundsvall, Sweden, has implemented a washing process allowing storage of fly ash on a landfill for non-hazardous waste.

Korstaverket Foto: st.nu

Method

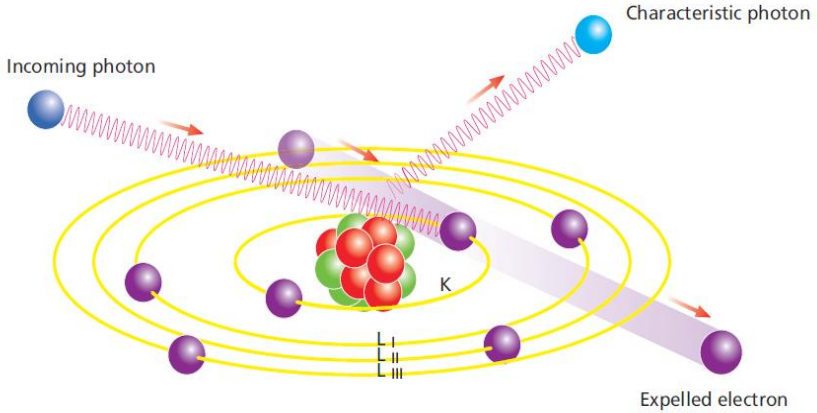

Figure 1. Production of characteristic radiation

Element	Fluorescence energy Kα1 (keV)	Fluorescence energy Kβ1 (keV)
Sodium(Na)	1.040	1.071
Sulphur(S)	2.307	2.464
Chlorine(Cl)	2.622	2.815
Potassium(K)	3.314	3.589

Table 1. Characteristic X-rays

- When a material is irradiated by X-rays or highly-focused energetic electron beams a photon can eject the electron from its atomic orbit.
- To fill this space, an outer shell electron can fall into an empty position of the ejected electron. The falling electron emits a characteristic fluorescent X-ray photon.
- The energies of the fluorescent photons are unique and can be used to identify the material.

Measurement setup

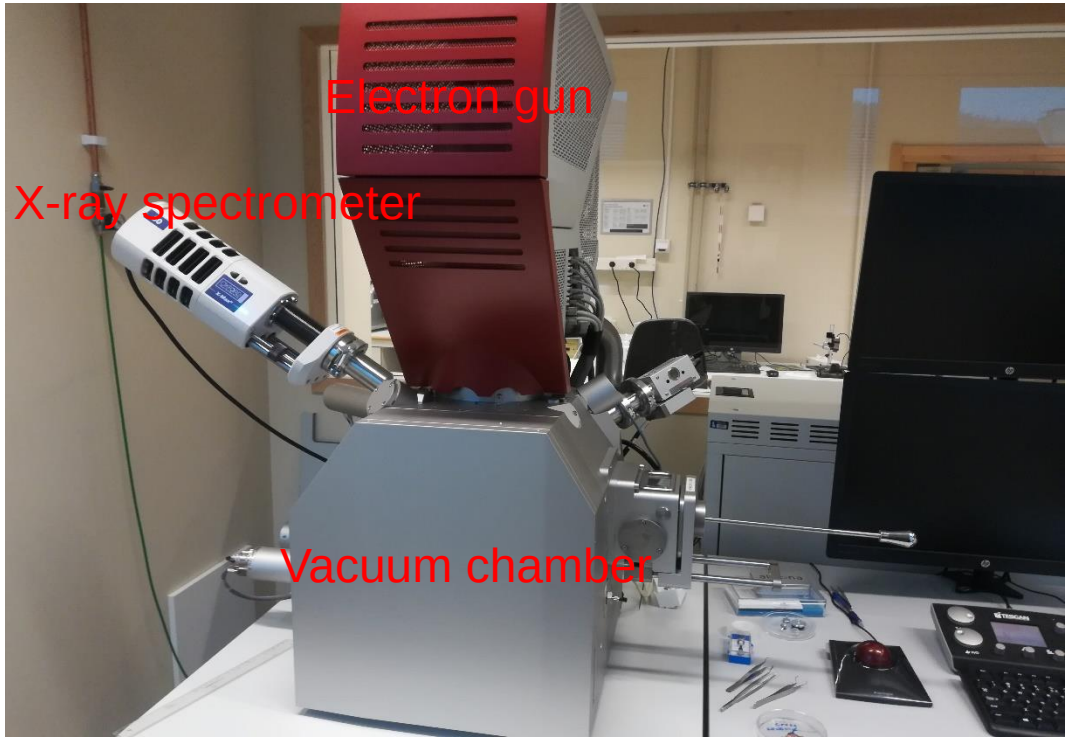

Fig. 2 SEM-EDS experimental setup

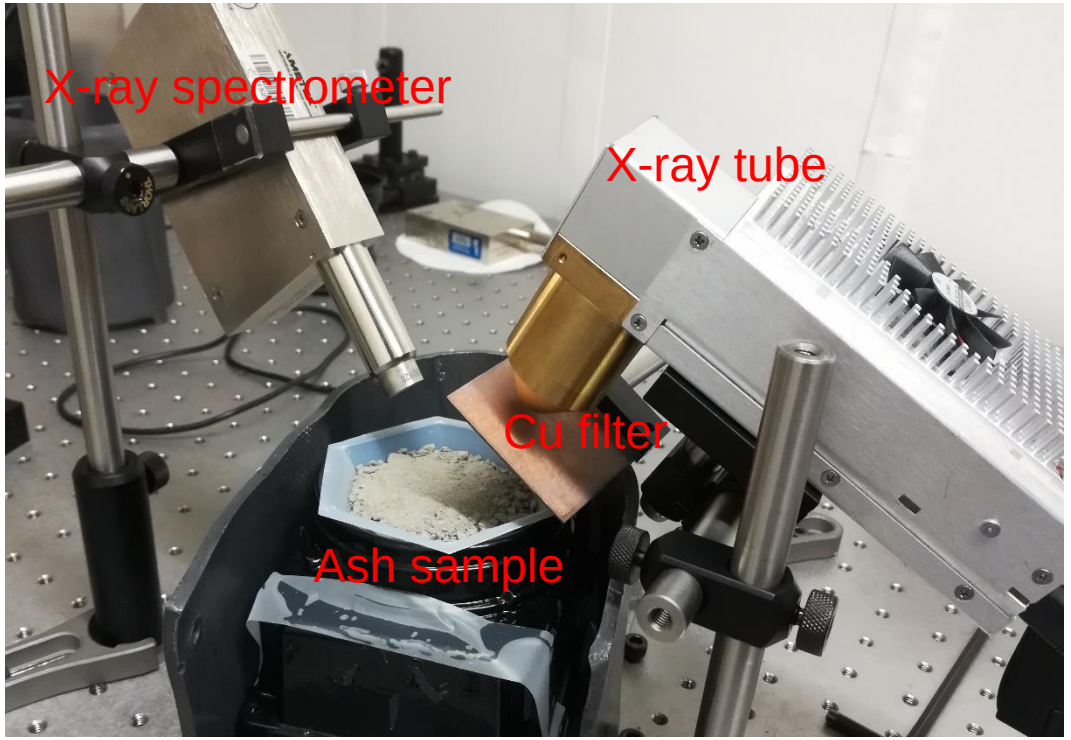

Fig. 3 XRF experimental setup, 1 mm Cu filter

Result

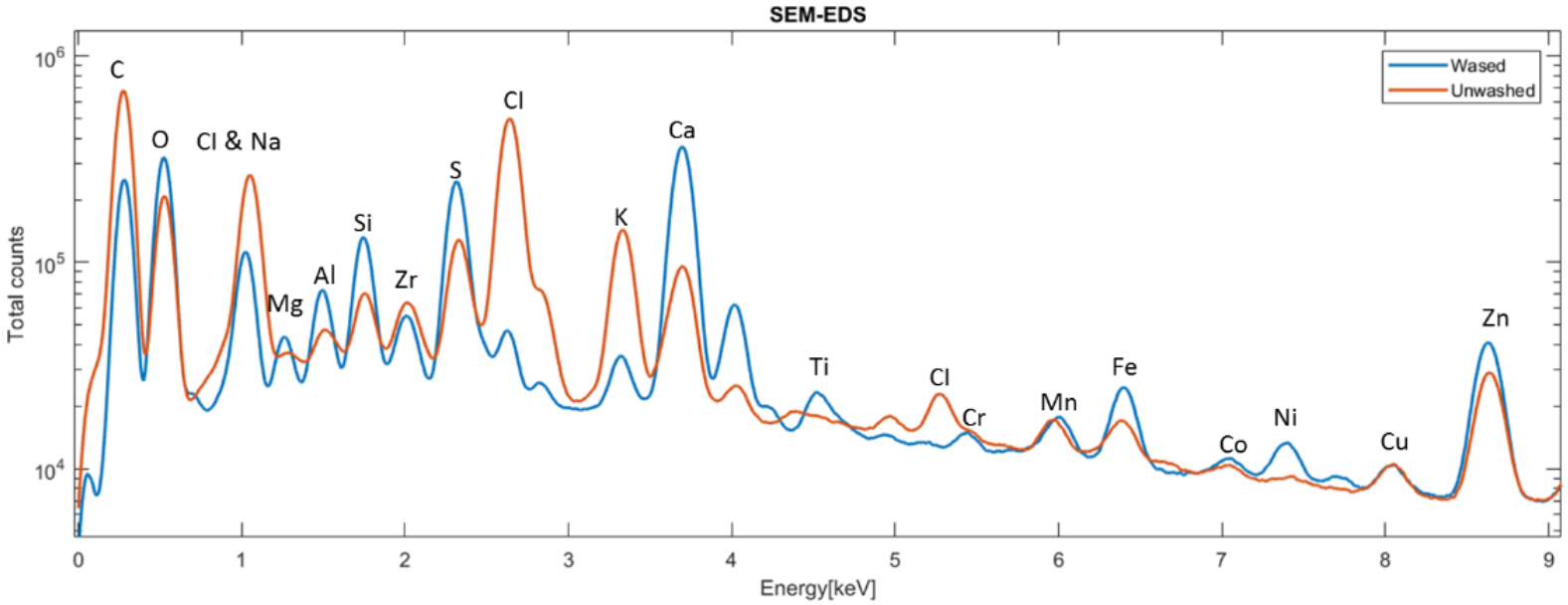

Fig. 4. Spectra of washed and unwashed ash sample, SEM-EDS, 20 kV, 5 mins

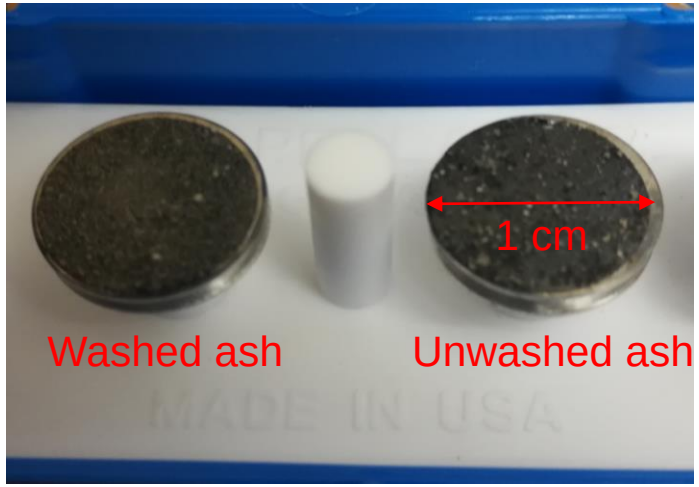

Fig. 5. Sample preparation of ash samples in SEM-EDS measurement, grinded

The peak area corresponds to a specific element concentration, it is also influenced by: fluorescence yield; sensor absorption; source penetration; sample thickness and density.

Result

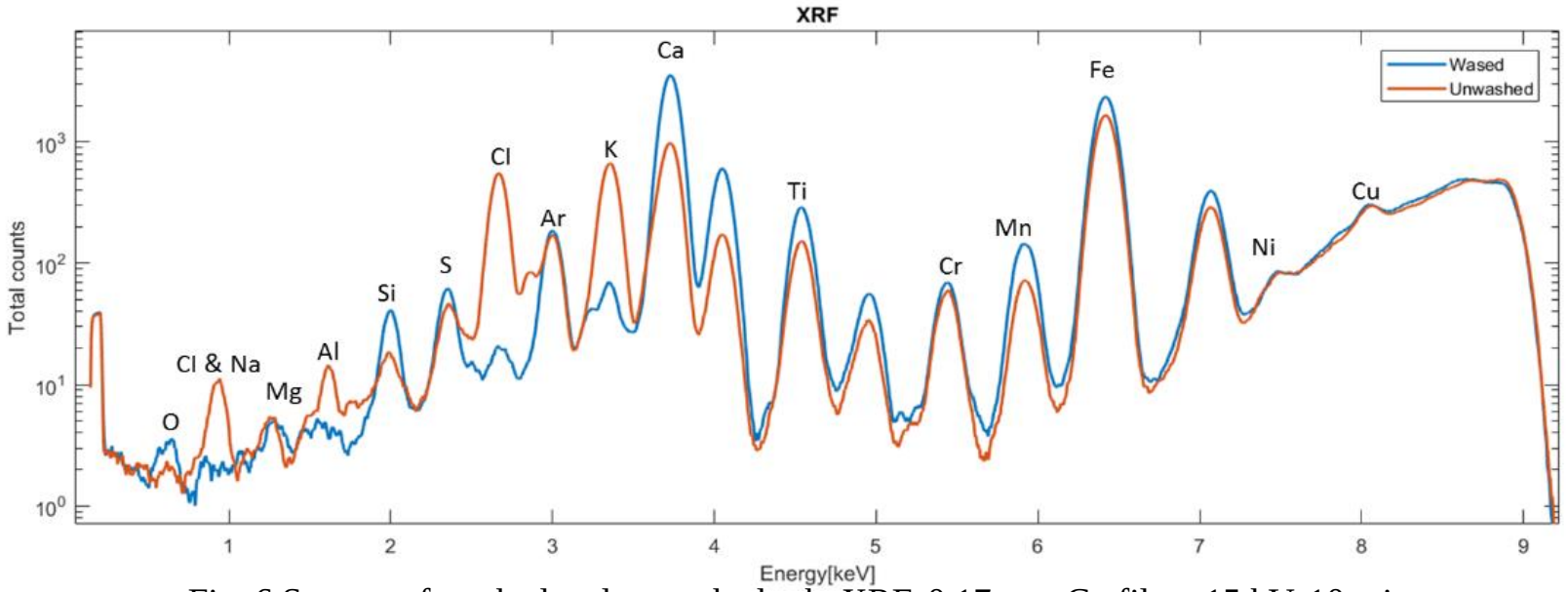

Fig. 6 Spectra of washed and unwashed ash, XRF, 0.17 mm Cu filter, 15 kV, 10 mins

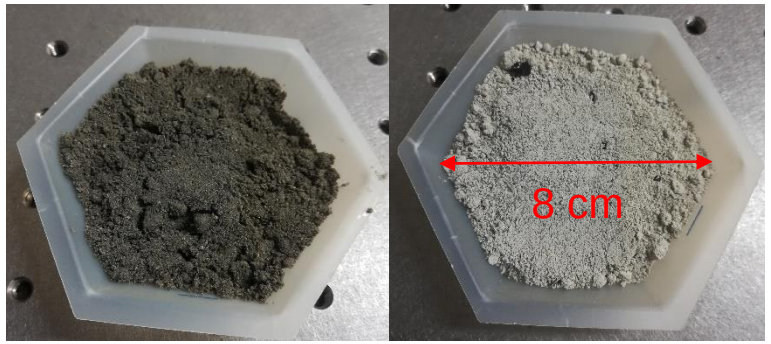

Fig. 7. Sample preparation of washed and unwashed ash in XRF measurement

The light elements below 1 keV are easily absorbed by air. It should be noted that there is no Argon(Ar) in the ash, but it presents in the spectra, because the normal atmosphere contains of Ar. To detect Hg at 10.0 keV a higher source energy must be used.

Conclusion

- Both XRF and SEM-EDS enabled determination for elemental analysis to monitor the washing process of fly ash from municipal solid waste incineration. Elements affected by the washing process are Na, S, Cl, K and other heavier hazardous elements like Hg.
- For low atomic number elements, having Z = 13 (Al) and below, the vacuum chamber of the SEM-EDS setup improves the analytical result due to removed air absorption.
- In samples containing many different elements, the peaks can distort each other, such as the Na peak is overlapped by the Cl escape peak. The further process for correcting escape peaks, sum peaks, and background removal must be considered.
- XRF is a potential method for online measurements of hazardous metal content in fly ash since it requires no specific sample preparation and can measure larger fractions of materials.

Thank you for listening!