Online Total Arsenic and Selenium Combination Analyzer For Mine Wastewater Remediation Process Control

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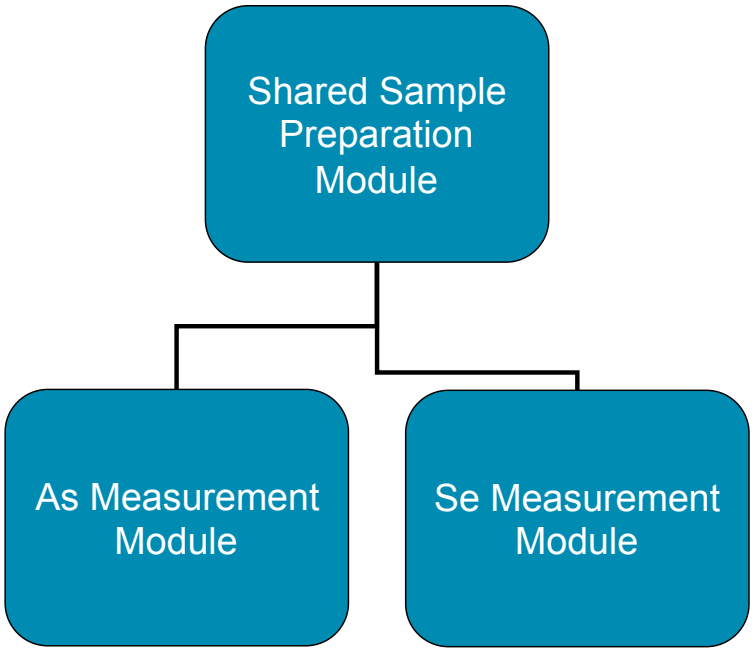
Background

- Single metal application specific both arsenic (As) and selenium (Se) on independent analyzers, has been previously reported
- In some wastewater treatment situations (mining, metallurgical, etc.) species of As and Se may be present at high levels and should be monitored
- Due to the complexity of As/Se measurement methods and interferences between their signals; determination of both elements in a combination analyzer has historically been difficult

Mining Wastewater - Total Metal Analysis Challenges

- Highly complex and frequently changing composition of mine influent (high TDS, TSS, metals, etc.)
- Effect of wastewater treatment method used on the effluent sample matrix (bio-treatment, etc.)
- Extensive sample preparation is required to mineralize (dissolve) insoluble Se and As species and convert them and make them suitable for measurement
- Electrochemically active As and Se species produce interfering signals. Trace Se analysis is highly difficult in presence of arsenite.

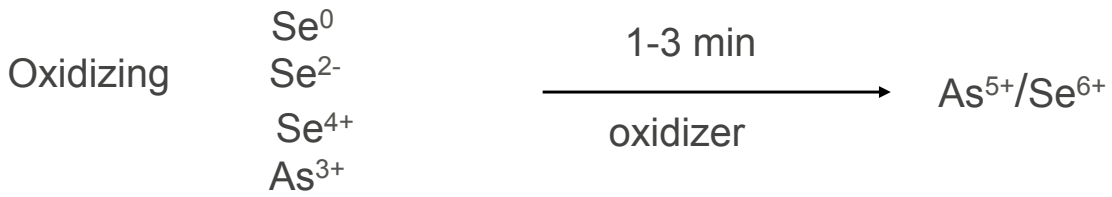
Our Approach to As/Se Combination Analyzer



- New versatile sample preparation method allowing sequential sample treatment for As/Se methods
- Elimination of mutual interferences between elements
- Highly efficient and automated pretreatment method (100% analyte recovery in less than 15 min.)

Sample Preparation for Total As and Se Analysis

1 Mineralizing entire As and Se species



During this step, entire reduced selenium forms and colloidal arsenic compounds under highly oxidizing conditions turn into soluble selenate and arsenate respectively and mineralized

2 Preparation for Total As Determination

Selective reduction of As^{5+} —(3min, As reducer)→ As^{3+}

3 Preparation for Total Se Determination

Selective reduction of Se^{6+} —(10 min, Se reducer)→ Se^{4+}

Se Determination using CSV- Measurement Principle

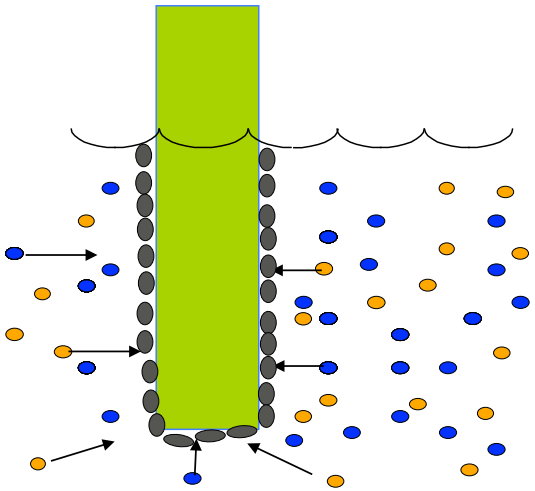
Step 1- Accumulation

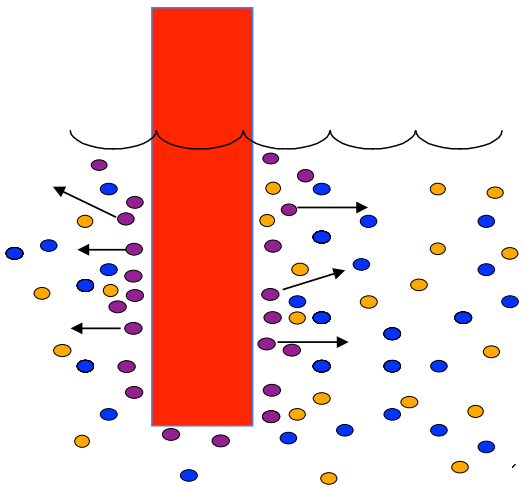
$2Cat + Se^{4+} + 8e^{-} \rightarrow CatSe$

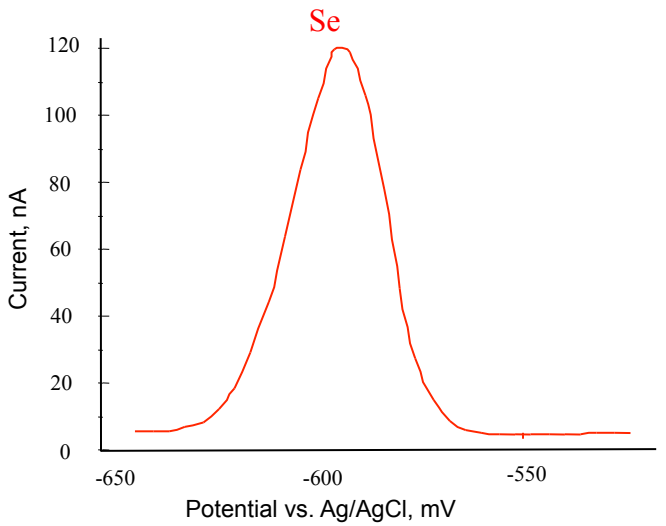
Step 2- Stripping

$CatSe + 2e^{-} \rightarrow 2Cat + Se^{2-}$

Resulting Signal

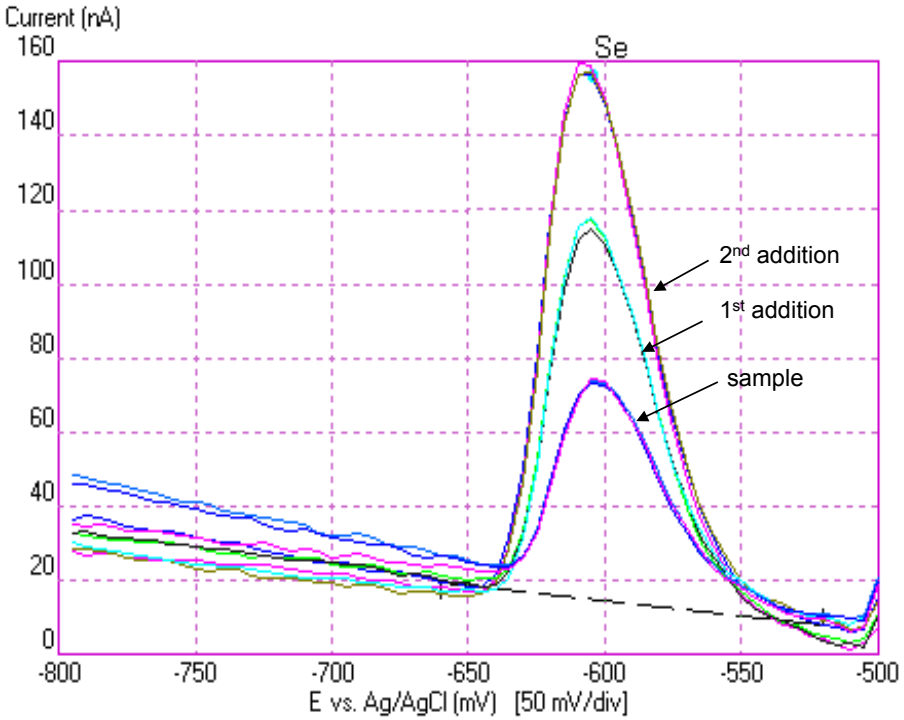


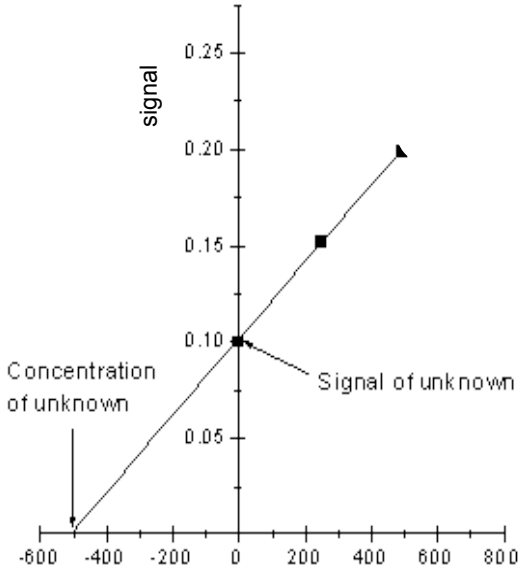




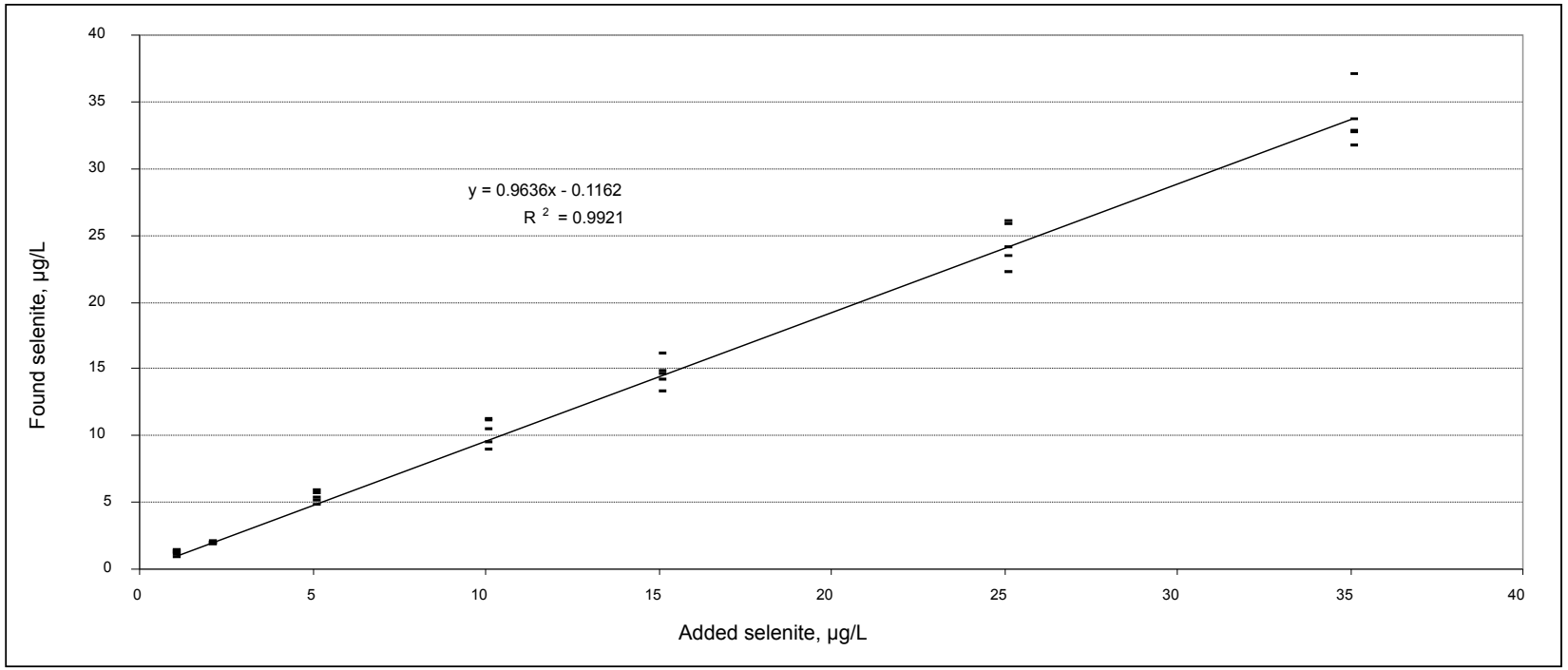
Se^{4+} Cat CatSe Se^{2-}

Quantification by MSA

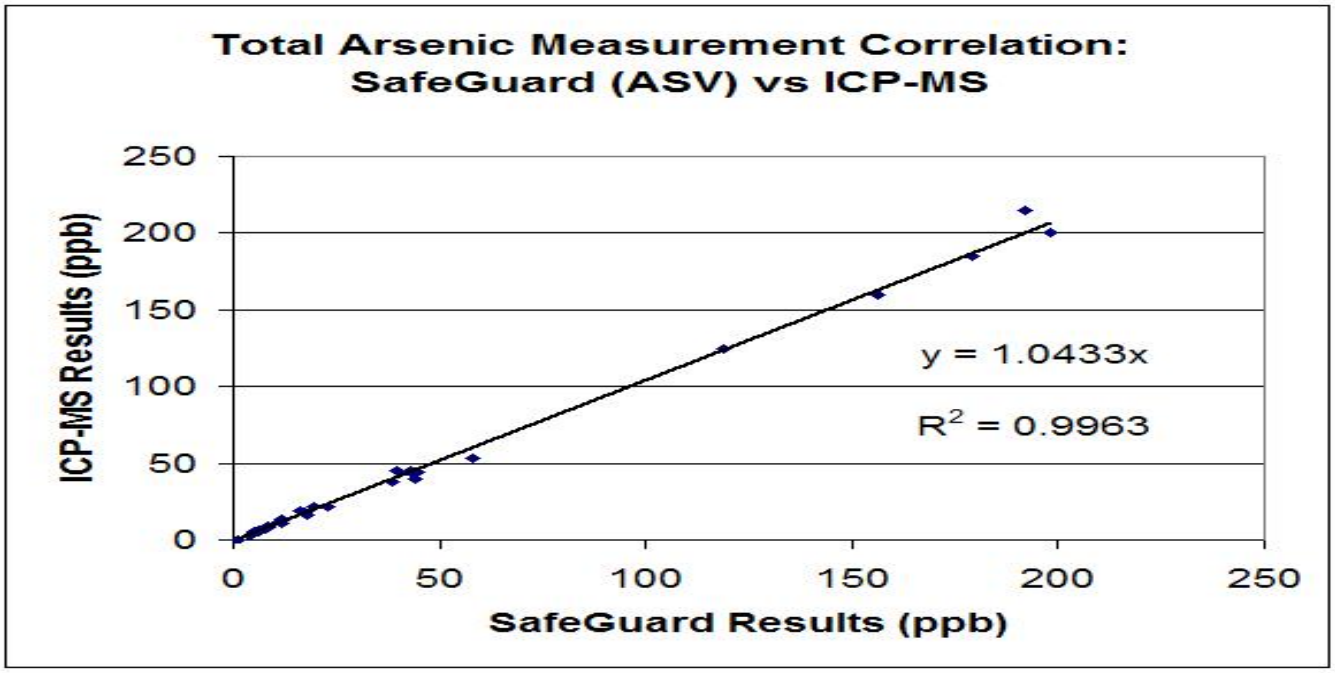




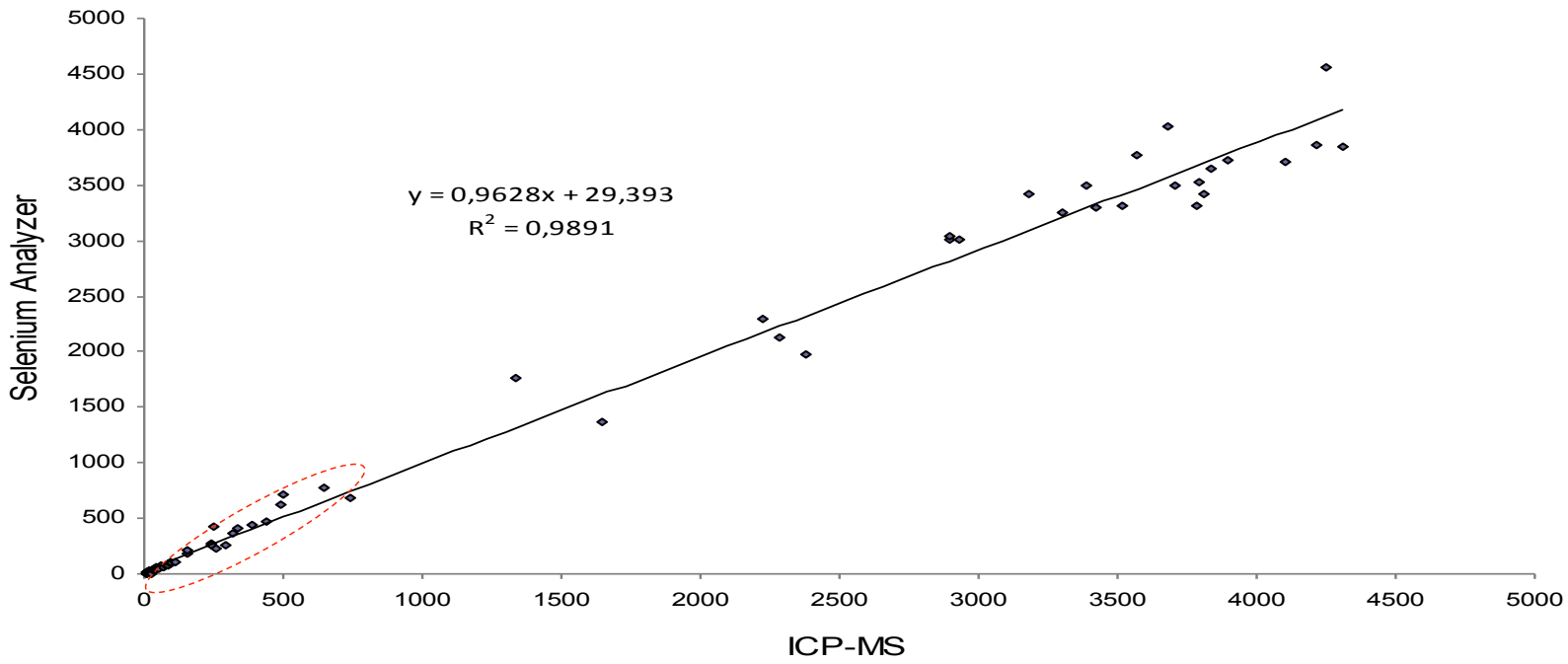
Determination of Se in Synthetic Samples



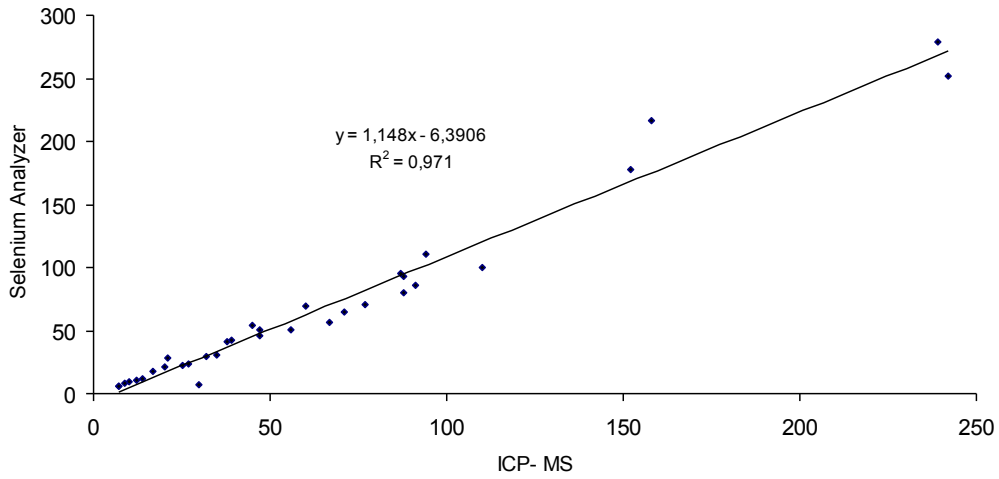
As Measurement Results- Correlation with ICP-MS



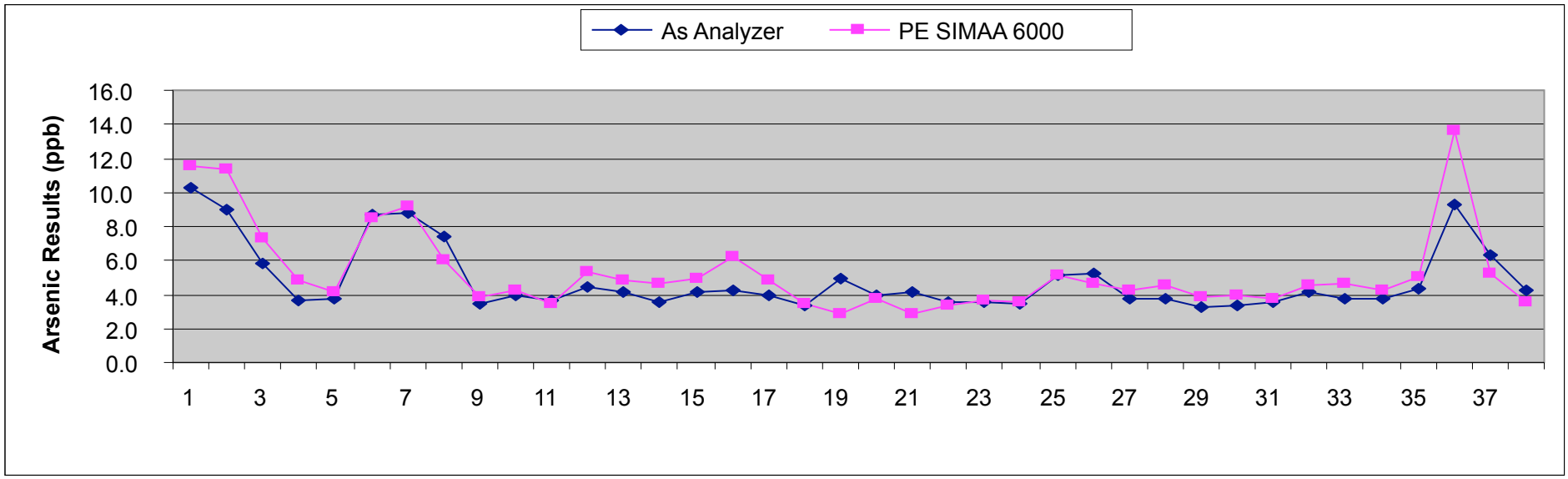
Se Correlation Results in Industrial Samples vs. ICP-MS



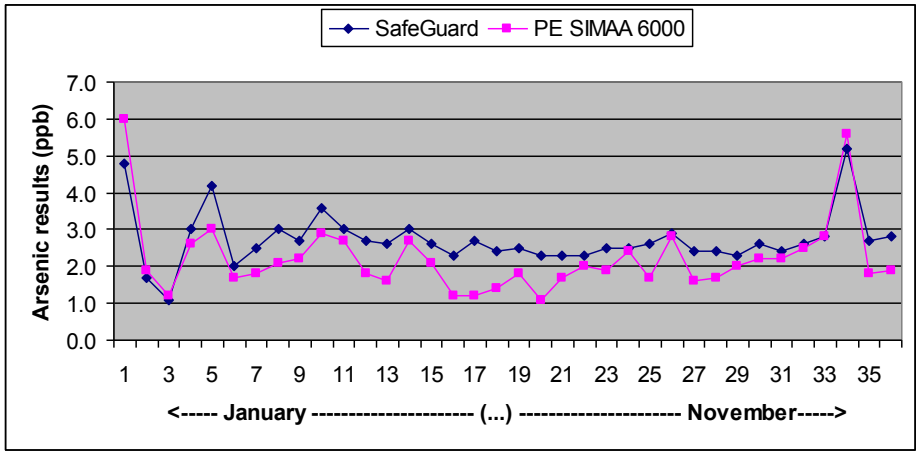
Correlation Results- 0-250 µg/L Range



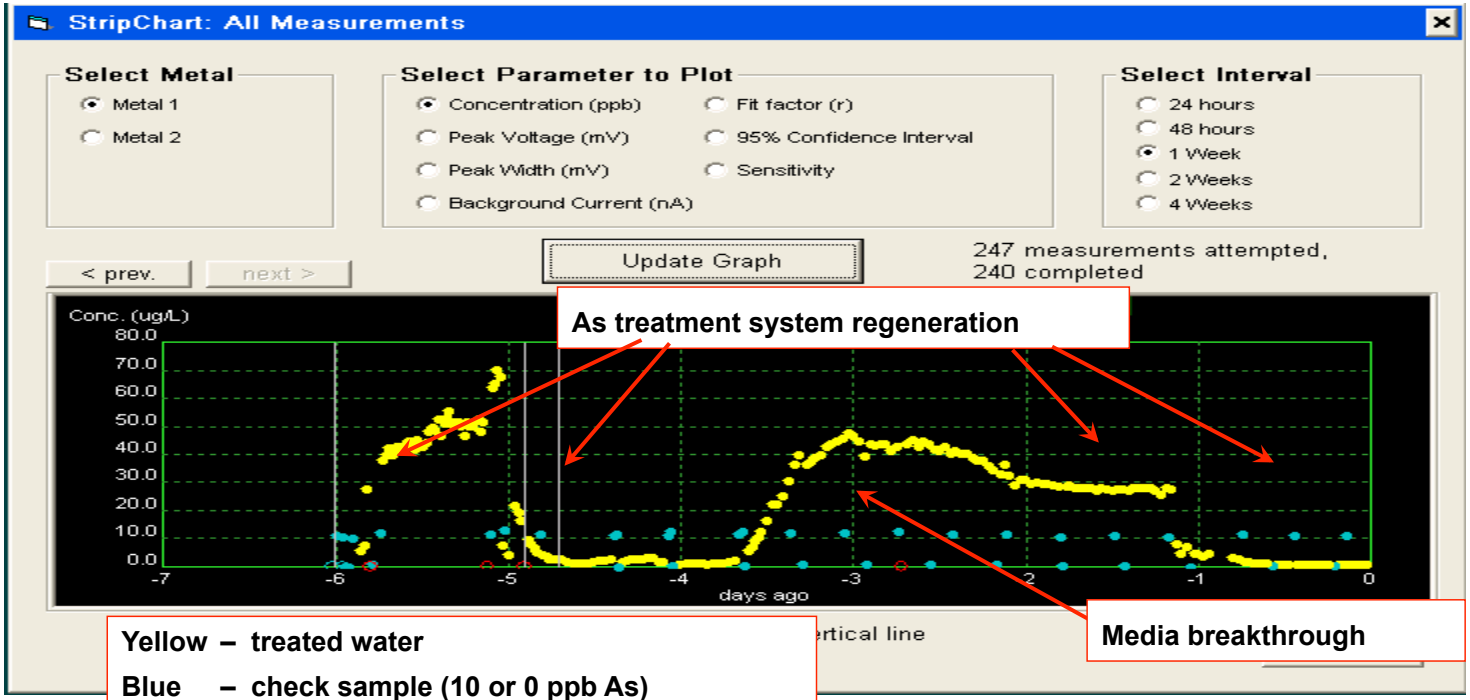
Raw Influent As Analyzer vs. Perkin Elmer SIMAA 6000



Combined Filter Effluent As Analyzer vs. Perkin Elmer SIMAA 6000



Accumulative Results of Total As Monitoring at Customer Site



Summary

- Total As/Se combination analyzer compatible with complex sample matrices has been developed
- Efficient and selective sample preparation methods for As and Se species have been determined and finalized
- Evaluation of new combination analyzer using real world mining samples and other industrial process samples is currently underway
- Universal electroanalytical method allowing integration of As and Se analytical methods using single probe is under development