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**Project Title:** Development of the determination of trace amount of anions and cations in ultra-pure power plant steam cycle water

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<b>Project Financial Code:</b>	216600	<b>Project Quality Code:</b>	PPCPN17
<b>Type of Project/Program:</b>	Idea test	<b>Assistant:</b>	Research Assistant

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### Project Necessity:

One of the most important issues of each power plant is about the purity of the power plant steam cycle water. To investigate this issue, it is required to determine the amount of anions, cations, amines and silica of the power plant steam cycle water regularly and continuously. Ion determination needs to be performed in various parts of the power plant steam cycle such as outlet and inlet of ion exchange column, inlet of the boiler and outlet of the condenser. Water quality refers to two categories of the impurities including control parameter (pH, conductivity, O<sub>2</sub>, Na<sup>+</sup>, Cl<sup>-</sup>, Si,..) and diagnostic parameter (Fe, Cu, Oil). Having information about the ion contains of power plant steam cycle water provide scientific detail about the reason of corrosion of the power plant's equipment. According to the recently published literatures, sodium and chloride is known to be the main factors for the corrosion of the power plants equipment.

### Project Goals:

We aim to analyses the anions and cations in sub µg/lit concentration range spontaneously without the need of sample preparation or off line preconcentration. Auto sampler is required to automatize the IC methodology. Moreover, the IC system in both anionic and cationic mode is equipped with two detectors, two chromatographic column, software with multiple channels and multiple channel interfaces. In overall, such an IC technique is able to detect both anions and cations of the power plant steam cycle water in one run spontaneously.

### Abstract:

Ion chromatography is well-known methodology to measure anions and cations of the water sample. Therefore, anions and cations detection is feasible by using IC without the need of any sample treatment, accessories or equipment. The IC technique possesses a detection limit in the range of mg/lit for the most anions and cations. One of the great aspects of IC technique is a possibility of measuring broad range of cations including amine, alkali metal ions and transition metal ion only by one run of analysis. On the other hand, IC method in anionic mode is able to detect Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, NO<sub>2</sub><sup>-</sup>, PO<sub>4</sub><sup>-</sup>, etc.

IC technique can be applied in both ion suppressed mode and normal mode. In ion suppressed mode, there is ion exchange column in acidic form after the separation column which results in changing salts to acids for all anionic species. As it is known,

the acidic form of anions has better conductivity than salt's. As a result, the acidic form of anions is monitored with higher signal compared to salt's which leads to improving the signal to noise ratio to ten times.

The lower limit of detection for ion suppressed IC is not low enough for anions and cations detection of power plant steam cycle water. Therefore, there is a need to develop a methodology which is able to improve the LOD to lower concentration than  $\mu\text{g/lit}$ . Improving the LOD of IC can be performed by direct large volume injection and using pre concentration column. By using direct large volume injection IC, the LOD reaches to  $\mu\text{g/lit}$  rang which is not yet enough to monitor such a low impurity of the power plant steam cycle water. Moreover, direct large volume injection is not reproducible enough. Furthermore, the chromatographic peaks are not sharp as it supposed to be and as a result, peak resolution and accuracy diminish.

To perform IC technique by using preconcentration column, the IC device needs to be equipped with preconcentration ion exchange column and pump at the injection valve. In this method, about 10 ml of sample is injected to the preconcentration column and then this sample is eluted with less than 50  $\mu\text{l}$  of eluent to inject into the separation column. In such a methodology, reaching into the sub  $\mu\text{g/lit}$  is feasible due to the 1000 times preconcentration factor. The reproducibility and repeatability are much better compared to large volume injection due to its automatization of the preconcentration step. On the other hand, the IC is equipped with ratio valve to prepare the calibration solution within the range of preconcentration  $\mu\text{g/lit}$  from stock sample to diminish the uncertainty of the preparation of the calibration solution.

### **Steps and Methodologies:**

1. Examining the previous methods of measuring ions and preparing the necessary preparations to implement the new analysis method
2. Preparation and installation of necessary equipment, multi-channel software and preparation of the system for final tests
3. Calibration, measurement and validation of the analysis system

### **Main Results (technical outputs, patents, papers, books, reports, etc.):**

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