# Real-time Monitoring of Ultrapure Water pH for Maintaining Device Integrity in Ultra-pure Processes Based on Experience of Wolsong Tritium Removal Facility (WTRF) at Nuclear Power Plant

Inhoon Lee, Yeonduck Han, Hojun Lee, Kyumin Song
*Korea Hydro & Nuclear Power (KHNP) CRI*
*hoony3437@khnp.co.kr*

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## 1. Introduction

Korea Hydro & Nuclear Power CO.LTD(KHNP) operates the Wolsong Tritium Removal Facility (WTRF), which was completed in 2007. During its initial operation, there were issues with copper corrosion of the packing used in the main equipment called Liquid Phase Catalytic Exchange (LPCE) Column. The packing is designed to last for the entire lifetime of the facility but needs replacement if corroded due to copper dissolution affecting its performance. Therefore, proper management of pH values in ultrapure water is crucial to maintain the performance of the copper packing.

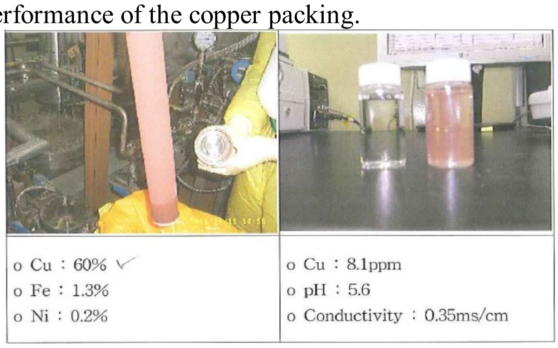


**FIGURE 1** Analysis value from KEARI and KHNP

## 2. Materials and Methods

In general, pH measurements are unreliable below an electrical conductivity of 1μS/cm. When the electrical conductivity drops below 0.1μS/cm, it becomes impossible to measure pH theoretically, as pH values range between 6.2 and 7.6 at this level.

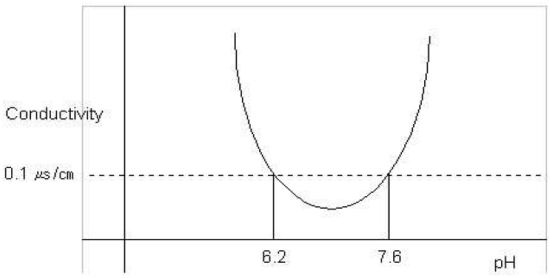


**FIGURE 2** Impossible zone of measurement pH

At WTRF, the electrical conductivity of feedwater entering the LPCE is managed to be less than 1μS/cm, making pH measurement challenging. Copper corrosion analysis showed that copper dissolves under acidic conditions (pH < 7), indicating the need for pH control when using metals like copper. Thus, monitoring the pH of ultrapure water is essential for devices made of copper and permanently installed, such as the LPCE's packing. Although pH sensors have low reliability in ultrapure water with an electrical conductivity below 1μS/cm, they provide reliable readings when the electrical conductivity is high enough. To overcome this limitation, we explored methods to mix impurities with known pH values to predict their concentration via calculations. By storing data on how pH changes based on temperature and impurity concentrations in a computer program, we can calculate the pH of ultrapure water by mixing appropriate amounts of impurities and ultrapure water according to the program's calculations. Sampling procedures ensure that no impurities enter the ultrapure water system after mixing, while using nitrogen as a carrier gas prevents any interference from gases.

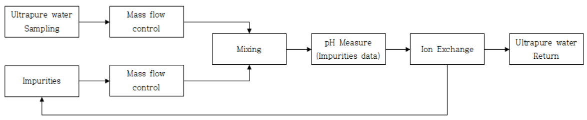


**FIGURE 3** Measurement Process of ultrapure water pH (< 1μS/cm)

## 3. Results and Discussion

With increasing use of facilities requiring ultrapure water, such as hydrogen electrolysis, it is difficult to detect pH changes in low-conductivity ultrapure water using pH sensors. Sample-based analyses also suffer from contamination risks and lack reliability. Changes in pH may lead to material degradation or other long-term impacts on plant integrity. Real-time pH monitoring is necessary for permanent installations or minimizing maintenance requirements. Our proposed method could serve as a solution for continuous operations without interruption. We plan to observe long-term data from the Wolsong Tritium Removal Facility (WTRF) to confirm its necessity.

## REFERENCES

[1] WTRF Operation Experience, 2010.