# Effects of Iodide and Hydrogen Peroxide on Measuring High Temperature pH in Various Lithium Borate Buffer Solutions

Jaesik Hwang, Myung Hee Yun, Jei-Won Yeon*, Kyuseok Song
*Nuclear Chemistry Research Division, Korea Atomic Energy Research Institute,*
*Daeduk daero 1045, Yuseong-gu, Daejeon 305-353, Korea*
** Corresponding author : yeonysy@kaeri.re.kr*

## 1. Introduction

In a reactor coolant system of nuclear power plants, the need for reliable high temperature pH electrodes has resulted from interests in the corrosion and corrosion product behaviors of the structural materials in a high temperature coolant system. In developing the electrodes for measuring the high temperature pH of aqueous solutions, it is necessary to note two major problems: the chemical stability of an electrode against other chemical impurities, and an electrode's integrity as the temperature and pressure are varied between operational extremes. Over the past decade Macdonald et al.[1-4] and Danielson et al.[5] have developed many ceramic membrane pH electrodes based on a yttrium stabilized zirconium oxide. However, there are still many experimental difficulties associated with the problems in obtaining electrochemical information across different pressure boundaries and against many kinds of chemical impurities caused by the radiolysis of water and the leakage of a fuel clad.

In the present work, we investigated the effects of the environmental factors on a high temperature pH. The selected environmental factors are as follows: system pressure, and chemical species such as iodide and hydrogen peroxide ions.

## 2. Methods and Results

A high temperature pH electrode was established by using yttrium stabilized zirconium oxide as an oxygen-ion-conducting membrane and Ni/NiO powder as an inner electrode. A once-through loop system equipped with a pH electrode and an Ag/AgCl reference electrode was used for measuring a high temperature pH in various lithium borate buffer solutions. The experiments were carried out in various lithium borate buffer solutions under high temperature and high pressure conditions. The pressure and the flow rate changes were controlled in the ranges of 100~200 $kg{\cdot}cm^{-2}$ and 5~30 $ml{\cdot}min^{-1}$, respectively.

### *2.1 pH in various B(OH)$_3$ / LiOH solutions*

The pH values increased with an increase of the Li concentration as shown in Fig. 2-1. This result was shown to be highly ideal.

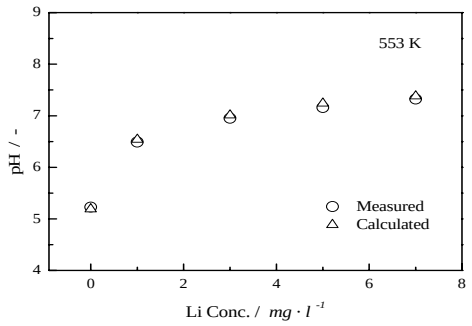


Fig. 2-1. The pH values in various $B(OH)_3$/LiOH solutions at 553 K.

### *2.2 Effect of pressure on the high temperature pH*

The dependency of the pH on the pressure was observed. The values of the pH decreased with an increase of pressure as shown in Fig.2-2.

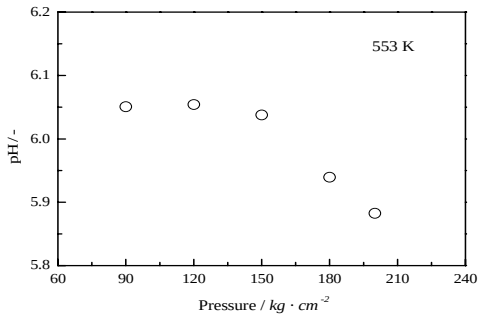


Fig. 2-2. Dependency of pH on the pressure at 553 K.

### *2.3 The effects of iodide and hydrogen peroxide*

The iodide ions and hydrogen peroxide are the chemical species easily observed in a reactor coolant system. For the investigation of these effects on high temperature pH, the concentrations of iodide and hydrogen peroxide were controlled up to 320 and 5 $mg\ l^{-1}$, respectively. As shown in Fig. 2-3, the pH values changed little in these conditions. Therefore, this result indicates that the pH electrode used in this work is applicable to the coolant system in the presence of iodide ions and hydrogen peroxide.

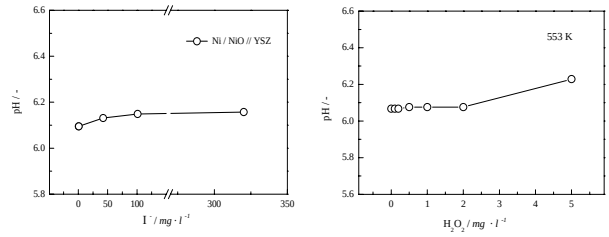


Fig. 2-3. Effects of iodide and hydrogen peroxide on the pH at 553 K

.

## 3. Conclusions

The dependency of the pH on the pressure was observed that the values of the pH decreased with an increase of the pressure. The chemical species such as the iodide (I-) ions and hydrogen peroxide had little impact, up to a considerable concentration, for measuring a high temperature pH. These results indicate that a pH electrode based on YSZ is applicable to a nuclear reactor coolant system.

## REFERENCES

[1] T. Tsuruta., D. D. Macdonald, Measurement of pH and redox potential in boric acid/lithium hydroxide buffer solutions at elevated temperatures. J. Electrochem. Soc. Vol.128, pp.1199–1203, 1981.
[2] T. Tsuruta., D. D. Macdonald, Stabilized ceramic membrane electrodes for the measurement of pH at elevated temperatures. J. Electrochem. Soc. Vol.129, pp.1202–1210, 1982.
[3] S. Hettiarachchi, D. D. Macdonald, Ceramic membranes for precise pH measurements in high temperature aqueous environments. J. Electrochem. Soc. Vol.131, pp.2206–2207, 1984
[4] S. Hettiarachchi, P. Kedzierzawski, D. D. Macdonald, pH measurements of high temperature aqueous environments with stabilized-zirconia membranes. J. Electrochem. Soc. Vol.132, pp.1866–1870, 1985.
[5] M. J. Danielson, O. H. Koski, J. Meyers, Recent developments with high temperature stabilized-zirconia pH sensors. J. Electrochem. Soc. Vol.132, pp.296–301, 1985.