# Effects of Dissolved gases on Measuring the High-Temperature pH in Various Lithium Borate Buffer Solutions

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## 1. Introduction

In nuclear power plants, the reactor coolant is mainly composed of water, and is highly corrosiveness in the condition of a high temperature and a high pressure. In particular, water radiolysis products brought about radiation emitted from the fuel rods may increase more corrosiveness. In the past days, coolants of nuclear power plants were controlled at the condition of reached minimum in the solubility of corrosion products such as magnetite and nickel ferrite. Whereas, the chemistry control of the coolants is urgently required due to the increase of CRUD deposition for the long-term fuel cycles. In the early days, the pH measurement at high temperature in the presence of hydrogen has been developed with Pt-H and Pd-H electrodes[1-5].

In the present work, we confirmed the performance of the Pt-H electrode and investigated the effects of dissolved gas such as dissolved hydrogen gas and oxygen gas.

## 2. Methods and Results

A high temperature pH electrode was established by using Ni/NiO mixed powder as an electrode material and yttria stabilized zirconia (YSZ) as an oxygen-ion-conducting membrane. A high pressure 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 solutions. Redox electrode in the present studies used Pt electrode. The experiments were carried out in lithium borate solution ($2.5 \times 10^{-4}$ *M* LiOH and $9.3 \times 10^{-2}$ *M* $B(OH)_3$) under high temperature(553K) and high pressure(100 $kg \cdot cm^{-2}$)

### *2.1 Effect of dissolved hydrogen gas on redox potential in lithium borate solution*

Fig. 1 shows the change of pH value in the condition with dissolved hydrogen concentration of 0 and 17.45 cc/kg, respectively. Redox potential decreased with an increase of high temperature pH value, and showed a linear dependence on pH value in the range of 4.8 to 7.0, this result was shown to be high ideal.

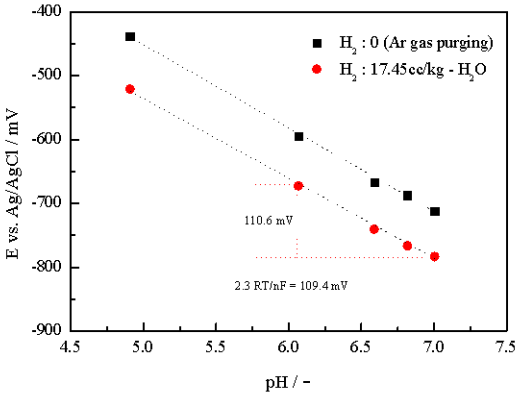


Fig. 1. Change of redox potential according to dissolved hydrogen gas concentration

Fig. 2 shows the pH value converted from redox potential and pH value measured by Ni/NiO/YSZ electrode, at calculated pH 7.0, under hydrogenated condition (17.45 $H_2$ cc/kg). The measured pH values by two different electrodes change little and showed the similar responses.

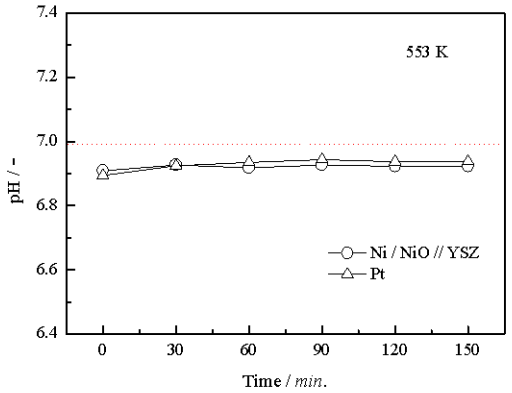


Fig. 2. Comparison of pH values obtained from redox electrode and Ni/NiO/YSZ electrode

### *2-2. Effect of dissolved oxygen gas on redox potential in lithium borate solution*

Dissolved oxygen gas at the high temperature may corrode the structural materials, and change the redox potential of the system, and cause deactivation of the pH

electrode using the Ni/NiO/YSZ system. The potentials measured by the Pt electrode and Ni/NiO//YSZ electrode in the condition with various dissolved gas were shown in Fig. 3. Dissolved hydrogen gas concentration was changed in the range of 4% to 100%, the redox potential moved within narrow limits at the potential range of - 0.60 to - 0.65 V, but the potential of Ni/NiO/YSZ electrode remained at constant value, -0.75 V.

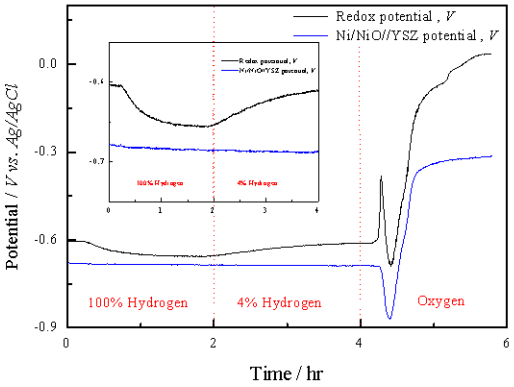


Fig. 3. Change of the potential according to the change of dissolved gases

### 3. Conclusions

The redox potential decreased linearly with an increase of the high temperature pH. At the comparison with the Ni/NiO//YSZ electrode and Pt electrode, the measured pH values showed similar responses. According to the change of the dissolved hydrogen gas concentration the redox potential moved within narrow limits but the potential of the Ni/NiO/YSZ electrode did not change. These results indicated that the Pt electrode and Ni/NiO//YSZ electrode can be used as a pH electrode, and be applicable to a nuclear reactor coolant system.

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