7-8 For Efficient H_2 Production Using IS Process –Success in Measuring SO_2 Pressurization Effect on the Bunsen Reaction–

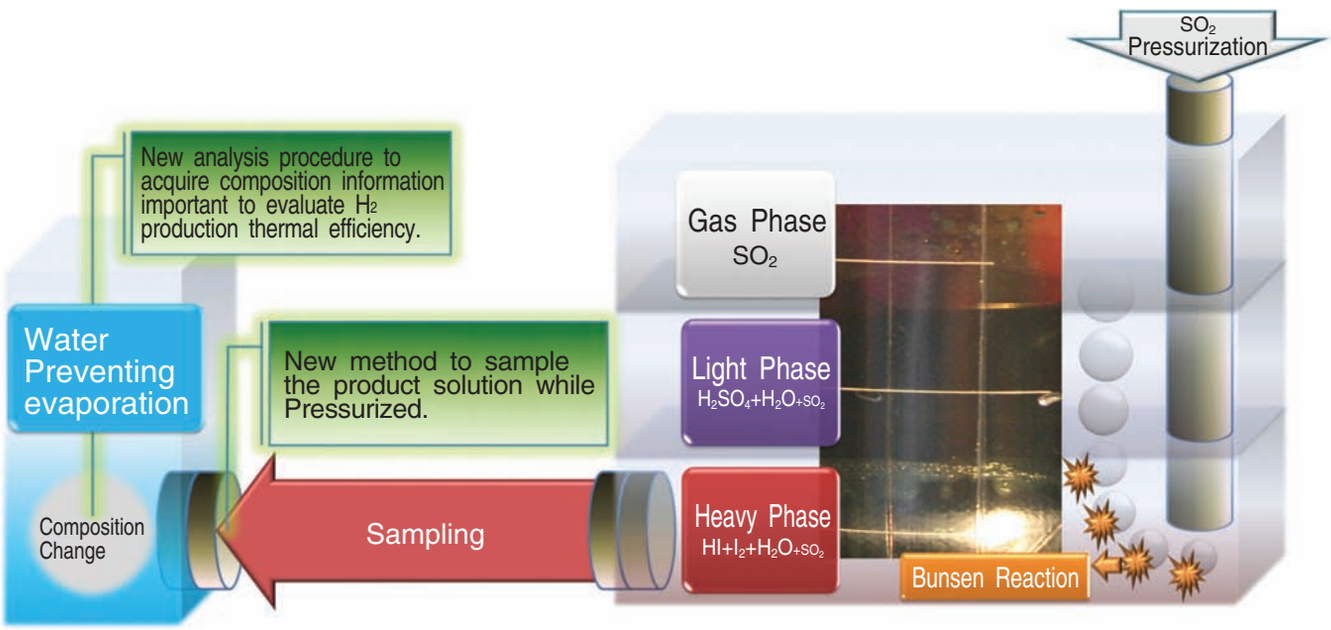

Fig.7-18 Outline of the method to measure SO_2 pressurization effect on the product of the Bunsen reaction
The Bunsen reaction is the most complicated reaction in the IS process and a key reaction for improving the efficiency of the H_2 production process. In this reaction, SO_2 gas contacts with a mixture of water and iodine, generating sulfuric acid and hydrogen iodide. The product solution separates into a light phase and heavy phase spontaneously.

We are investigating a large scale hydrogen (H_2) production method, the IS process, using a High Temperature Gas-cooled Reactor (HTGR) as the heat resource. By using the IS process which is a thermo-chemical reaction cycle using Iodine (I) and Sulfur (S) as recycling agents, H_2 can be obtained from H_2O without emitting CO_2.

The following reaction is the Bunsen reaction which is one of the major reactions in the IS process.

$$SO_2+I_2+2H_2O \rightarrow H_2SO_4+2HI$$

By obtaining a highly concentrated solution of sulfuric acid (H_2SO_4) and hydrogen iodide (HI), we can reduce the separation energy of H_2SO_4 or HI from H_2O and other impurities, which is essential for high thermal efficiency of the IS process. From Le Châtelier's principle, by increasing the iodine (I_2) concentration and the partial sulfur dioxide (SO_2) pressure, the reaction equilibrium shifts to the product side. We have found that increasing the I_2 concentration is effective, but it has been a problem how to measure the SO_2 pressurization effect.

There was no indirect measurement method suited to this pressurized system, because of I_2 dissolving in the product solution (the heavy phase, Fig.7-18). Even in the case of direct composition analysis using sampling method, it was the problem that the components dissolved in the product solution dissipated into the atmosphere during sampling and the composition change due to the reaction between the product solution and the water to prevent evaporation of the product solution.

We developed a new method of direct composition analysis by which we could sample the product solution while maintaining the reaction conditions including the high pressure. To deal with the composition change caused by water, we devised an analysis procedure of the post-reaction composition to acquire the composition information needed to evaluate the H_2 production thermal efficiency.

With this method, we can easily search for favorable reaction conditions for obtaining more concentrated product solution and thus accelerate the development of an efficient H_2 production process.

Reference

Nakajima, H., Imai, Y. et al., Effect of Sulfur Dioxide Partial Pressure on the Reaction of Iodine, Sulfur Dioxide and Water, Kagaku Kogaku Ronbunshu, vol.33, no.3, 2007, p.257-260 (in Japanese).