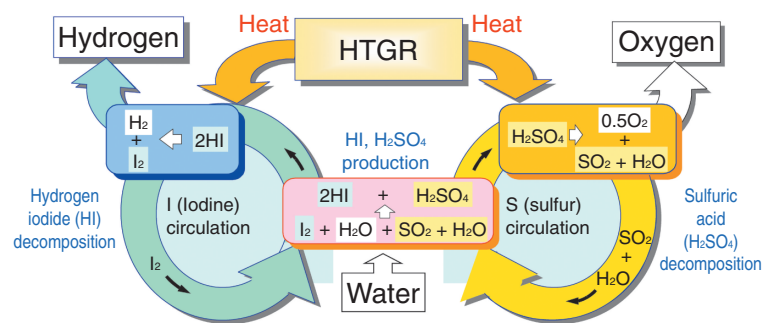
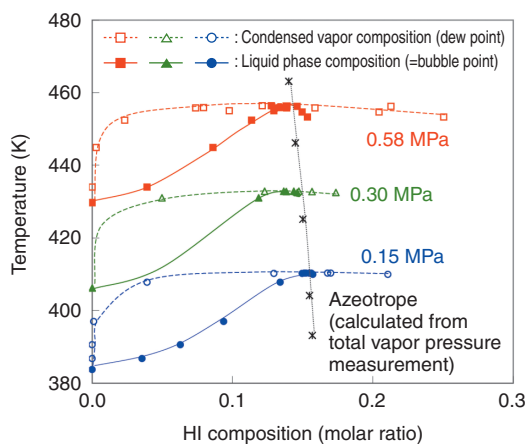


## 7-8 Toward Efficient Hydrogen Production by Thermochemical IS Process — Measurement of High Pressure Vapor-Liquid Equilibrium of Hydriodic Acid —



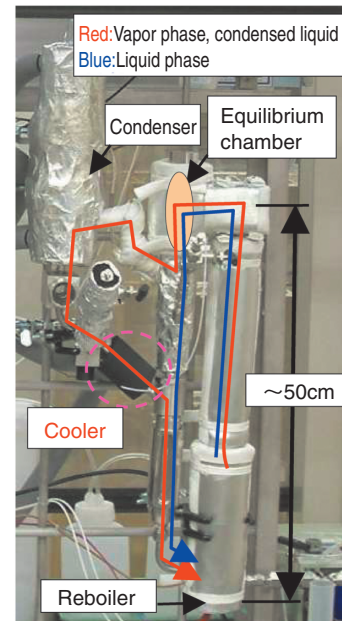
**Fig.7-19 IS process**

HI and H<sub>2</sub>SO<sub>4</sub> should be separated from HI+I<sub>2</sub>+H<sub>2</sub>O mixture and H<sub>2</sub>SO<sub>4</sub>+H<sub>2</sub>O mixture, respectively, before decomposition.



We are conducting R&D of thermochemical iodine-sulfur (IS) process, which can produce massive amounts of hydrogen from water without CO<sub>2</sub> emission, using the heat supplied by High Temperature Gas-cooled Reactors (HTGR). Fig.7-19 shows the scheme of IS process. Water (H<sub>2</sub>O) reacts with iodine (I<sub>2</sub>) and sulfur dioxide (SO<sub>2</sub>) to produce hydrogen iodide (HI) and sulfuric acid (H<sub>2</sub>SO<sub>4</sub>), which are then thermally decomposed, producing hydrogen and oxygen, respectively. One of the difficult technical requirements of the process is efficient separation of HI from HI+I<sub>2</sub>+H<sub>2</sub>O mixture. Distillation under elevated pressure is the promising candidate. However, little is known about the relevant vapor-liquid equilibrium (VLE).

Therefore, we have started the acquisition of VLE data. Our first target was the VLE of hydriodic acid, the two component system of HI+H<sub>2</sub>O. At first, the materials for measurement devices which can be used in the highly corrosive HI+H<sub>2</sub>O solution were screened. Next, using the



**Fig.7-20 VLE measurement device**

Vapor-liquid mixture flows up from the reboiler to the equilibrium chamber, where the equilibrium state is realized. Vapor is separated and condensed in the condenser. Vapor condensate and liquid phase are returned to the reboiler. After reaching steady state, the liquid phase and the vapor condensate are sampled and analyzed.

**Fig.7-21 VLE data of HI+H<sub>2</sub>O mixture**

The point where dew point curve and bubble point curve contact is the azeotropic point where equilibrium compositions of vapor phase and liquid phase are the same.

selected materials, a measurement device was constructed as shown in Fig.7-20. Here, in order to avoid the re-boiling of vapor condensate in the recycle line due to the large difference of boiling points of the vapor condensate and the liquid phase, a cooling system was added.

Fig.7-21 shows the obtained VLE data. HI+H<sub>2</sub>O is known to exhibit azeotropy, where compositions of the two phases of HI+H<sub>2</sub>O are identical. The measured azeotropic points were well in accord with those estimated from the former data of total vapor pressure measurement, which demonstrated the reliable accuracy of the developed measurement system. The equilibrium composition data of vapor and liquid phases newly acquired in the present study will enable precise design of the distillation column with smaller redundancy.

The acquisition of high pressure VLE data of three component system of HI+I<sub>2</sub>+H<sub>2</sub>O system is under study. The VLE database will enable the compact and efficient design of the key separation apparatus of IS process.

### Reference

Hodotsuka, M., Yang, X., Okuda, H., Onuki, K., Vapor-Liquid Equilibria for the HI + H<sub>2</sub>O System and the HI + H<sub>2</sub>O + I<sub>2</sub> System, Journal of Chemical & Engineering Data, vol.53, no.8, 2008, p.1683-1687.