Advanced Core for Energetics, Hiroshima University Vol. 70

HU-ACE NEWS LETTER

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Activities of the Core

Oct. 5, 2022	The 109th HU-ACE Seminar (The 128th Mechanical Systems Seminar)(co-organization).
Oct. 6, 2022	In the magazine "The Japan Association of National University" No. 65 LEADER'S MESSAGE, an article about a conversation between President Ochi and Associate Professor Kindaichi was published.
Oct. 13, 2022	The 75th HU-ACE Steering Committee Meeting.
Oct. 20, 2022	The 7th Hiroshima University Biomass Premium Evening Seminar (co-organized).
Oct. 25, 2022	The 110th HU-ACE Seminar (The 1st Geothermy seminer).
Oct. 26, 2022	The 26th Biomass Project Research Center Symposium(co-organized).

We publicized Hiroshima Scenario

Hiroshima Scenario to realize decarbonized society, which has been discussed in the International Symposium on Fuels and Energy (ISFE) hosted by HU-ACE, in the form agreement of related members can be obtained. Hiroshima Scenario for decarbonization proposes (1) Electrification of apparatus using city gas, LPG, gasoline, diesel, and kerosine, (2) Provision of solar electricity using farmland etc., (3) Using batteries for mismatch of power generation and electricity demand, and (4) Introduction of technologies for energy conservation such as underground heat, renewable energy such as biomass, substitute battery such as electric vehicles to reduce energy cost.

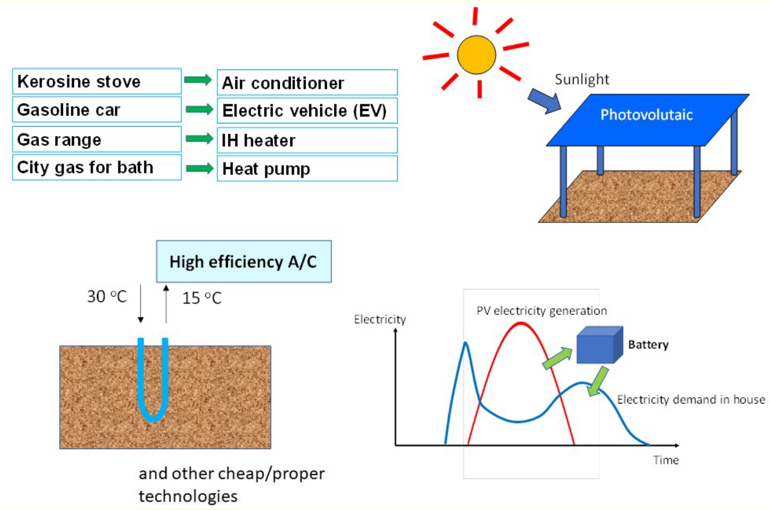

Fig. Hiroshima Scenario

It can be downloaded from the portal site of HU-ACE (https://hu-ace.hiroshima-u.ac.jp/). We appreciate the cooperation of related members and would like to ask you to distribute this concept and to continuously cooperate on the discussion so that we can further develop this scenario.

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HU-ACE Secretariat, URA Division, Office of Research and Academia-Government-Community Collaboration, Hiroshima University 1-3-2 Kagamiyama, Higashi-Hiroshima, 739-8511 Japan
e-mail: hu-ace-info@ml.hiroshima-u.ac.jp, tel:+81-82-424-4613
URL: https://hu-ace.hiroshima-u.ac.jp/en/

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Research Topics No. 36

Superdense surface state of liquid hydrogen

ICHIKAWA, Takayuki
Graduate School of Advanced Science and Engineering, Professor
A-ESG Science and Technology Research Center

Research fields: Materials Engineering for Energy Conversion and Storage
Keywords: Hydrogen Storage Materials, Carbon recycling, Ammonia

Abstract

Background

Hydrogen produced from renewable energy is named as “GREEN” hydrogen, and various energy carriers have been proposed, researched and developed to improve the efficiency and cost of its transportation. In Japan, liquid states of hydrogen, ammonia, methane, and methylcyclohexane are regarded as possible energy carriers. Among them, liquid hydrogen has a boiling point of 20K and a critical temperature of about 33K, in which a handling technology in such an extreme condition is required. In this case, the pressure resistance of the thermally insulated container in which the liquid hydrogen is stored, is not so high, and the gaseous hydrogen must be leaked and discharged to the outside by boil-off due to the small heat flow.

Methods

Adsorbents are generally used to immobilize molecules on the surface in a gaseous state, and are usually used for gas separation by pressure swing adsorption(PSA) using differences in adsorption characteristics, and for deodorization by adsorption of molecules that cause bad odors. On the other hand, since hydrogen becomes supercritical above 33 K and 1.3 MPa, research is conducted by using the adsorption phenomenon to store hydrogen at ultra-high pressures above several tens MPa near room temperature, or to store it at liquid nitrogen temperature. In this study, we would make a clear distinction from these studies, and proceed with research aimed at “controlling thermodynamic properties” using adsorption phenomena at liquid hydrogen temperature using highly porous materials. Here, the activated carbon (MSC-30) is focused, which has a high specific surface area of about 3000m^2/g, and compared its adsorption properties below the critical temperature.

Results

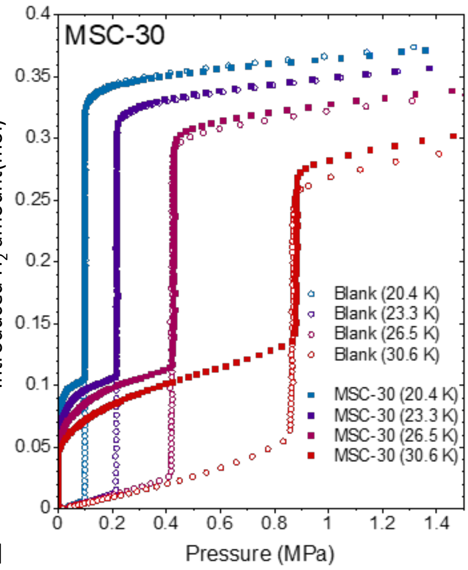

Figure shows the relationship between the pressure and the introduced H_2 amount when it was introduced at each temperature (20.4 to 30.6 K) into a container filled with and without MSC-30. The large difference from these profiles at low pressure indicates an increase in the introduced H_2 amount due to adsorption on the surface of activated carbon. In addition, at the liquefaction pressure at each temperature, a gas-liquid phase transition was observed, and it can be seen that the introduced amount increased greatly. Under these circumstances, it is worth noting that the results at 20.4K showed that the total H_2 amount was almost the same regardless of whether activated carbon was charged or not. It was considered that this phenomenon occurred because the density of hydrogen adsorbed on the surface of activated carbon was extremely high, although the introduced amount into the vessel decreased by the volume of activated carbon removed. Furthermore, the difference gradually increases as the temperature rises. Although the density of H_2 near the liquefaction pressure at each temperature decreases as the temperature rises, the density of the adsorbed hydrogen remains almost constant regardless of the temperature and pressure. This phenomenon resulted in a slight control of the thermodynamics of the vapor-liquid equilibrium in the insulated vessel.