Foreword

Hydrogen is an ideal fuel for fuel cells, which can convert its energy into electricity through a highly efficient electrochemical reaction with heat and water as the by-products. The resulting fuel cells can be used in vehicles for zero-emission transportation to support sustainable urban development, for un-manned aerial vehicles (UAV), and other portable applications, including electronic devices. Hydrogen can also be produced from water by electrolyzers driven by excess renewable power, storing that excess power in the form of chemical energy in fuel cells which allow it to be converted back to electricity when the renewable power available is insufficient. Thus, hydrogen can serve as an ideal carrier for renewable energy storage, enabling wider application of renewable energies such as solar and wind power. It is expected that hydrogen will play an important role in future sustainable energy systems. Over recent decades, extensive research has been conducted into hydrogen production, storage, and conversion, and the technological and economic feasibility of hydrogen energy for various applications has been evaluated. I am honoured and delighted to introduce six papers on this subject to the readers of the HKIE Transactions issue on the theme of hydrogen power.

The article by Ping Pan CHAN discusses the feasibility of hydrogen trains in Hong Kong. A qualitative approach is used to discuss the political, economic, social, and technological aspects of introducing these trains, then a quantitative approach is adopted to gauge the carbon footprint savings of this measure. Assuming that the hydrogen train will be introduced to the Northern Line, East Kowloon Line, and South Island Line (West), the total annual CO₂ saved is found to be 190,522 tons. In the end, recommendations are made for introducing hydrogen trains to Hong Kong.

The first article by Yi CHEN (Part I) reports an interesting idea to upgrade biogas through hydrogen enrichment for use as a domestic fuel. Biogas is a promising fuel, but its environmental performance is affected by its carbon content. By mixing 80% biogas with 20% H₂, the stagnation heat flux of the impinging biogas/H₂ flame is increased, although the thermal energy efficiency could be decreased slightly by 6.3%. In the Part II paper, the pollutant emissions from H₂-enriched biogas are studied. After H₂ enrichment, the mixed fuel emits significantly less CO and CO₂ compared to standard biogas fuel. Its CO emissions are also lower than that of LPG. This study clearly demonstrates the potential of biogas and H₂-enriched biogas as a cost-effective and environmental-friendly fuel for domestic use.

In Jeffrey Kwok's paper, the seven roles of hydrogen energy in the energy transition are discussed, including large-scale integration of renewable power into the power grid, mediums for distributed energy generation and energy storage, and clean fuel for fuel cell vehicles for

transport decarbonisation. Hydrogen fuel can be used for decarbonising building energy consumption as well. They also present applications of hydrogen power worldwide to illustrate its current status. The article concludes that hydrogen energy can enable the transition to a net-zero emissions world.

Pradipto Suwidji, et al., summarise the progress in practical hydrogen production and utilisation in East Asia. Typical hydrogen production technologies include reforming of fossil fuels such as natural gas, water electrolysis, biomass thermochemical processes, thermochemical water splitting etc. Then hydrogen energy applications in China, Japan, and South Korea are introduced. Although hydrogen energy applications in East Asia are still in their initial stages, hydrogen energy is expected to play an important role in future energy systems for a sustainable society.

Bin Wang et al. report on an interesting study on green hydrogen production from water by solar photocatalysis. One challenge for effective solar photocatalytic water splitting is the fast recombination of the photogenerated electrons and holes. Wang et al. developed B,F-codoped TiO₂ nanosheets loaded with Pt nanoparticles. The morphology and crystal phase of the synthesised photocatalyst are confirmed with a transmission electron microscope (TEM) and X-ray diffraction (XRD) characterisation. It is found that the bandgap of the photocatalyst is reduced by Pt modification, resulting in visible absorption and improved photocatalytic performance. Compared with nanosized TiO₂ photocatalyst, the hydrogen generation rate using the newly developed photocatalyst loaded with Pt nanoparticles is improved by a factor of about 40. This research demonstrates the great potential of green hydrogen production from water using solar photocatalysis.

I'd like to express my sincere gratitude to the HKIE Secretariat, members of HKIE Transaction Committee, the authors, and reviewers for their time and efforts in launching this interesting theme issue on hydrogen power for the benefit of the engineering profession in Hong Kong and the rest of the world.

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