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Supply of Carbon-Neutral Drop-in Fuels by the Biomass-Nuclear Synergistic Process

Masao Hori

Nuclear Systems Association
1-7-6, Toranomon, Minato-ku, Tokyo, 105-0001, Japan (E-mail: mhori@mxb.mesh.ne.jp)

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A. Outline

For the fuel demand of passenger vehicles, which will be decreased in the future by the plug-in hybrid electrification, carbon-neutral drop-in synthetic fuels are to be supplied. To meet this demand, synthetic fuels produced by the biomass-nuclear synergistic process(1) are supposed. Results of investigation on supply capability, environmental / energy effects and other important issues regarding the fuels are presented.

B. Estimation

1. Assumption of Passenger Vehicles and Fuel Consumption in 2050 Japan

Powertrain composition: PHEV 80% and BEV 20%
Number of total passenger vehicles in 2050: 72,000,000 (PHEV 57,600,000, BEV 14,400,000)
Average distance travelled by a vehicle: 6000 km
Avearge PHEV specification: (Fig.1)
Battery capacity 9 kWh, 8 km/kWh DC(All Electric Mode in the CD range of SOC 100 to 25%)
Fuel consumption in the CS range: 22.0 km/L gasoline

2. Electric and Fuel Range of PHEV

Electric run distance: = 54 km
Utility factor (Fraction of electric run Fig.2) = 0.7 for average Japanese passenger vehicles from the statistical data
Fraction of fuel run = 1-0.7 = 0.3

3. Total Fuel Consumed by Passenger Vehicles in 2050

By volume; 4.72×10^9 liters gasoline, by energy 13.64×10^{11} MJ or 3.76 $Mton_{OE}$

4. Fuel Production by the Biomass-Nuclear Synergistic Process

Method: Steam gasification of biomass with heat input from nuclear reactor (No combustion of biomass, all the carobn in biomass available for fuel production) (Fig.3)
Necessary biomass quantity: 3.52 $Mton_{OE}$ (8.3% of estimated available biomass in Japan)
Necessary nuclear heat: 0.942 $Mton_{OE}$ (Corresponding to the output of 3 high temperature reactor plants of 600 MW_t)

5. Battery Capacity of Powertrain Composition of PHEV 80% and BEV 20%

Total battery capacity of the PHEV 80% BEV 20% fleet is 38% of the 100% BEV fleet (Assuming BEV battery 40 kWh)

C. Results

- For the PHEV 80% and BEV 20% fleet, percentage of electric run distance is 76% and fuel run distance is 24%.
- Fuels consumption for above passenger vehicles is reduced to about 10% of current passenger vehicles'.
- Necessary quantities of biomass and nuclear energy for producing carban neutral syntheci fuels for the above fleet are within the available capacity of both resources.
- The PHEV powertrain is important to decrease the total capacity of battery used, which is effective to reduce CO_2 emission during battery fabrication and required battery materials.
- Accerelation of development of high temperature nuclear reactors for fuel production is important.

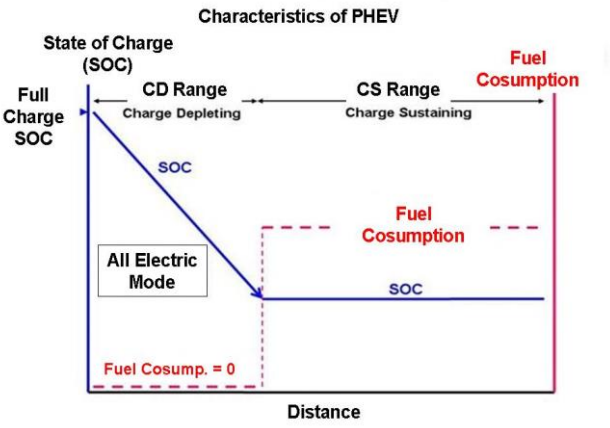

Fig.1 Battery SOC and CD Range Distance

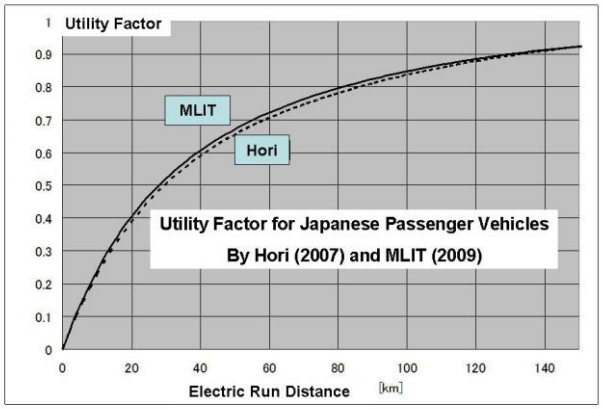

Fig.2 Utility Factor for Japanese Passenger Vehicles

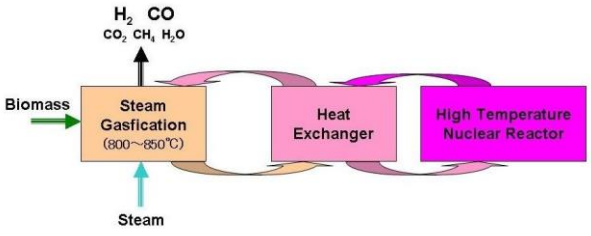

Fig.3 Concept of Biomass-Nuclear Synergistic Process for Carbon-Neutral Synthetic Fuel Production

(1) Masao Hori "CARBON-NEGATIVE ENERGY SYSTEM - Sustainable World Energy Supply and Global Environment Restoration Using Renewable and Nuclear Energies" Japanese Edition with English summary, Amazon Kindle B083G1278K (Jan 2, 2020)