Use of Decarbonized Fuels in The Industrial Sector

Jun'ichi Sato

Decarbonized Industrial Thermo-System Center

Decarbonized Industrial Thermo-System Center (DITS)

- **President**: **Dr. Jun'ich SATO**

- **Founded : May 11, 2023**
  One of the association of "**Collaborative Innovation Partnership**" approved **by the Ministry of Economy, Trade and Industry**

- **Members**
  - **19 Companies (Manufacturer, User, Fuel Supplier)**
    Air Water, CATALER, Chugai Ro, Fuji Denshi, Fuji Electric, IHI-IMS, JFE, JSW-ME, KYK, MITSUI & CO. , NIPPON STEEL, Nissan, ROZAI, RYOBI, SANKEN, TYK, TOKYO GAS, TOKYO ROPE MFG, UACJ

  - **12 Universities**
    Gifu University, Hiroshima University, Hokkaido University, Ibaraki University, Kyoto University, Kyushu University, Meijo University, Nagoya Institute of Technology, Osaka University, Tohoku Univ ersity, The University of Tokyo, Yamaguchi University

  - **1 National Lab.**
    National Institute of Advanced Industrial Science and Technology

R&D Programs of DITS

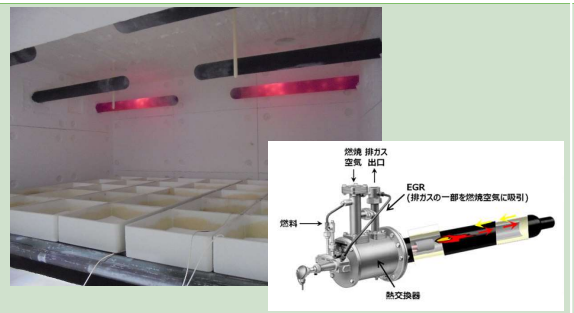
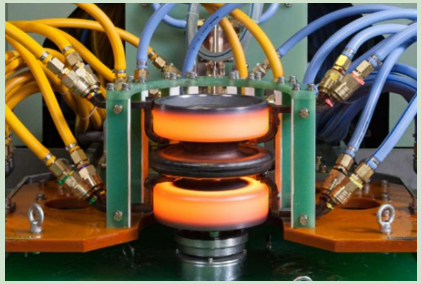
13.5% of CO2 emission of Japan (150 Mtons) is from the industrial furnaces. It is about 40% of the CO2 emission from the industrial sector. 39,000 industrial furnaces are used for heating the materials in the manufacturing processes.

1. **Research on Fundamental Technologies Applying Decarbonized Fuels to the Industrial Furnaces**
2. **Development of Ammonia-Fired Industrial Furnaces**
3. **Development of Hydrogen-Fired Industrial Furnaces**
4. **Development of Electric Furnaces with Higher Efficiency and Lower Power Supply Capacity**

Larger size combustion furnaces

	Steel Heating Furnace	Steel Process Furnaces	Steel Forging Furnace	Aluminum Melting Furnace
Appearance		 	 	
Usage	Ironmaking (heating slabs prior to hot-rolling)	Ironmaking (heating for microstructure adjustment in the final stage of sheet metal production)	Steel forging (heating of forging materials)	Aluminium materials (ingot melting)
Furnace temp.	MAX. 1400℃	MAX. 950℃	MAX. 1400℃	MAX. 1200℃
Capacity	MAX. 180MW	MAX. 18MW	MAX. 9MW	MAX. 19MW
Dimensions	11mW x 56mL x 5mH	2.4mW x 16mL x 25mH	8mW x 13mL x 8mH	Φ10m x 5mH

Smaller and medium sizes of combustion furnaces and electric furnaces

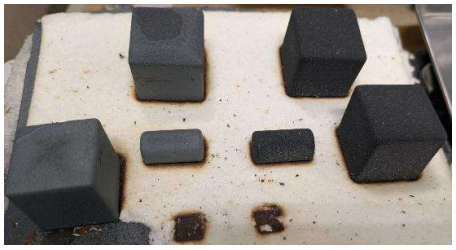
	Ammonia Fired Radiant tube burner	Inductive and resistive hybrid	Ammonia reforming unit
Appearance		 Figure shows the induction device section.	
Usage	Heat treatment	Heat treatment	Attachment of Burner System
Features	● Indirect heating system. ● Stable combustion is required in the narrow space inside the tube	● Hybrid of induction furnace using electromagnetic induction of coils and resistance furnace using electrical resistance.	● Catalytic reforming of ammonia to hydrogen.
Heating temperature, dimensions, etc.	Max. Temp.: 1000℃ Capacity : ①150kW、600℃ ②300kW、1000℃	Max. Temp.: 600℃ Size : 1～2mW×1.82.3mL×1.5×2.0mH	Capacity : 50～400kW class Size : Φ0.3m×1m

Decarbonized Fuels

- **Hydrogen**
- **Ammonia**
- **Synthetic methane (Hydrogen + DAC)**
- **Biogas (Methane)**
- **Biomass (Solid and Liquid)**

Request for industrial furnaces

- No damage on the heated products (Hydrogen embrittlement, Nitriding on the surface, etc.)



- Achieving required heating processes (Temperature history and Temperature distribution) of the products

Request for industrial furnaces

- Safety operations of furnace systems (Industrial safety and health regulations)

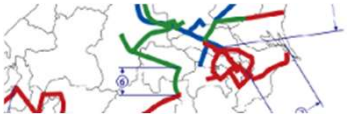
- Lower emission levels (Environmental regulation, NOx, NH3, N2O)
- Longer lifetime of furnace systems
- Lower price level of furnace systems

Request for fuel supply systems

- **Safety operation of fuel supply systems (Industrial safety and health regulations)**
- **Stable supply of fuels (How much fuels used per day)**

Ships: Hydrogen (liquid), Ammonia (liquid)

Pipelines: Hydrogen (high pressure), Ammonia (liquid)



Natural gas pipeline

Railways: Ammonia (liquid)

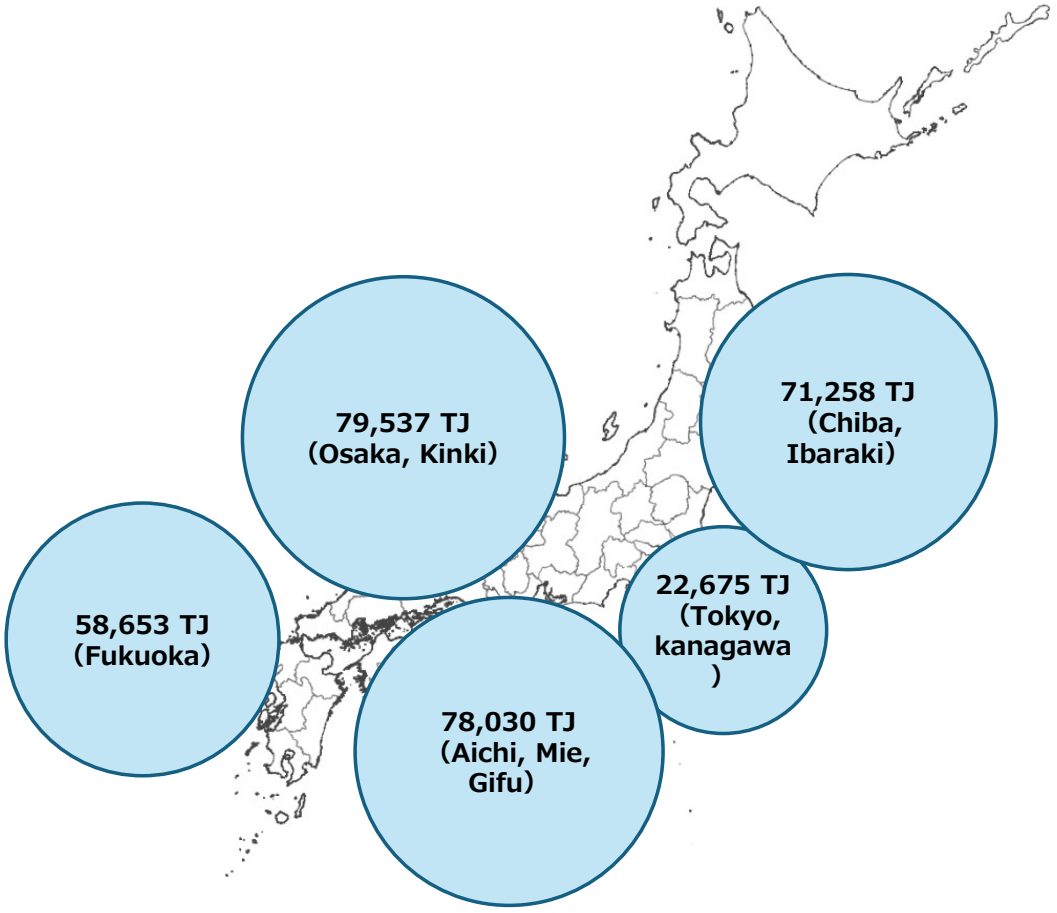
25 tons/wagon

Tanker Trucks: Hydrogen (high pressure), Ammonia (liquid)

0.25 tons/truck

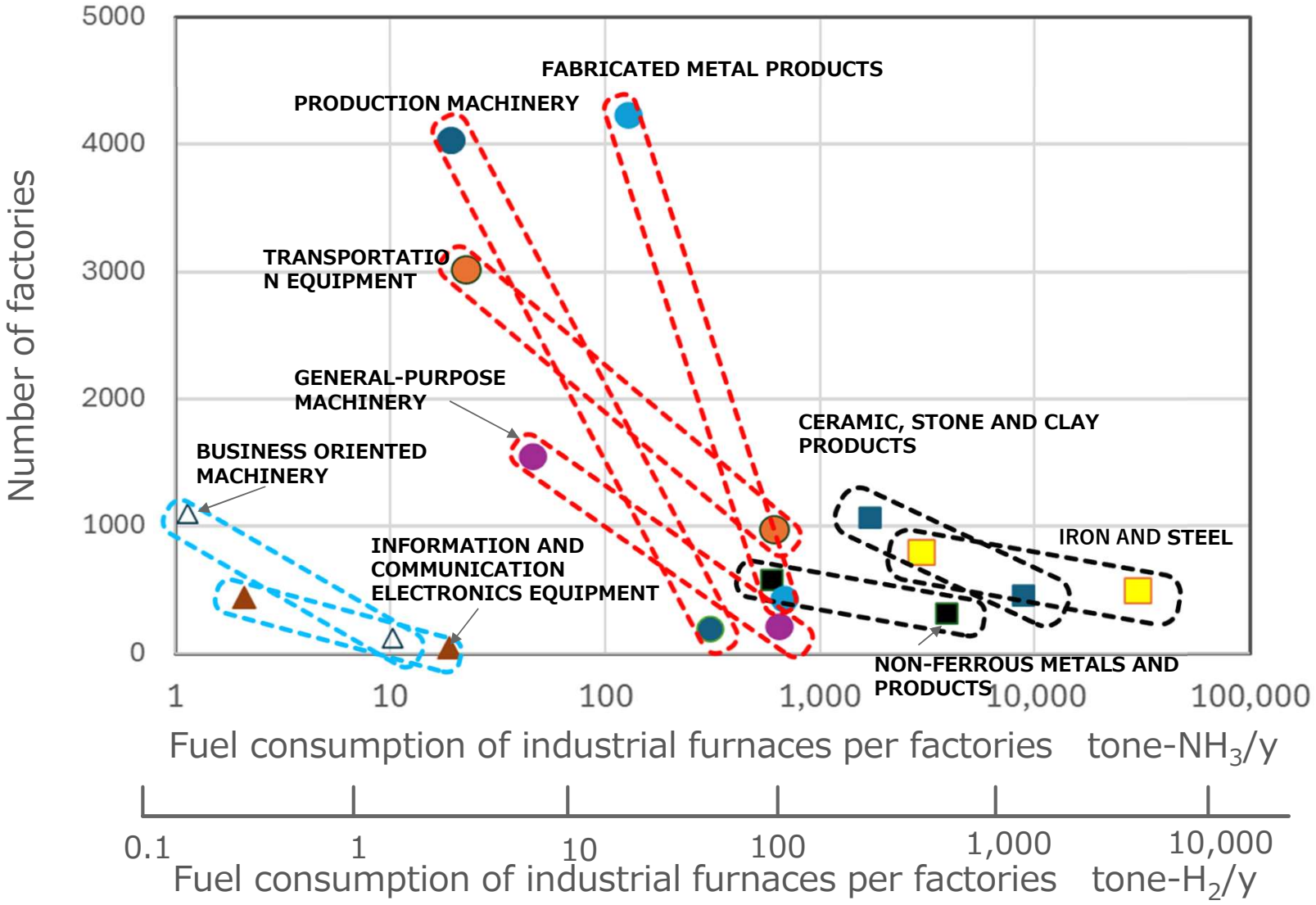
10 tons/truck

Fuel consumption of industrial furnaces



Map of industrial furnaces (combustion) in the central aria

Fuel consumption of industrial furnaces VS number of factories



- Many problems exist for applying decarbonized fuels in the industrial sector.

  Problem is not only the NOx emission levels.

- Problems are not the same as the power sector.