Growing Potential of Fuel Ammonia

Fourth East Asia Energy Forum
‘A Low-Carbon Energy Transition in the ASEAN Region’
13 September 2021

Yoshikazu Kobayashi
The Institute of Energy Economics, Japan (IEEJ)
Saudi Aramco and IEEJ with Japanese firms jointly conducted production, shipment, and utilization of blue ammonia in 2020.

- CO2 emitted from NH3 production is captured and utilized for EOR and methanol production in Saudi Arabia. Imported ammonia was used as fuel.

**Diagram:**
- Natural gas
  - CO2 capture
  - CCU
  - Ammonia plant SAFCO @Jubail
  - Methanol plant @Jubail
  - EOR@ Uthmaniyah

**Flow:***
- Associated gas
  - 20 tons
  - Mixed combustion with natural gas
  - 30 tons
  - Mixed combustion with coal
  - 40 tons
  - Sole combustion

**CO2 Capture:**
- 40 tons
- 30 tons
- 20 tons
Characteristics of ammonia as fuel

- No CO2 emissions at combustion

- Established international market
  - Currently used as a feedstock of fertilizer and chemical products
  - Infrastructure (production plants, storage, loading facility, tankers etc.) exists.
  - Pricing mechanism / cost structure are well known.

- Various patterns of utilization
  - Utilized as a carrier of hydrogen
  - Technological development enabled direct use by mixed combustion.
  - In addition to mixed combustion with coal, utilization at gas turbine, industrial boiler, vessel engines is possible.

- Various production sources
  - Clean ammonia is produced from “blue” and “green” hydrogen
  - Competitive hydrogen supply is important.
Cost of supply

- At this stage, ammonia is regarded as the most cost competitive mean of hydrogen supply.
- Current supply cost target is $350/MT.
  - $0.09/kWh if used by 20% mixed combustion with coal at power generation.

Source: IAE
Market for fuel ammonia will be large compared to the current international ammonia market

- If ammonia is used as mixed combustion at 20% in all large coal power plants in Japan, the demand will be a half of the world’s ammonia trade.
- The total demand of ammonia in the world (~200 million tons) is far larger than the traded volume.
Expanding supply chain capacities

- Supply chains need to be built up.
  - Typical size of large-sized ammonia plant is one million ton per year.
  - If the market takes off and the demand grows in Asia, significant expansion of production capacities is required in addition to hydrogen production, tankers to transport, port/loading/unloading facilities.
Issues

- **Cost**
  - Still not comparable to conventional thermal power generation
  - Ammonia production is relatively matured technology.

- **Logistics**
  - Necessity to expand capacity of all value chains from production, shipping, receiving capacity, and consumption

- **Market effects**
  - Potential impacts on the existing ammonia market
  - If blue hydrogen is extensively used as a feed stock, it may also affect the world natural gas market.

- **Safety issue**
  - Manageable by specialized operators without problem
  - Prioritized use power generation and industrial fuel