

"HTGR", H₂ production with superior-safety nuclear reactor

Organization

Japan Atomic Energy Agency (JAEA)

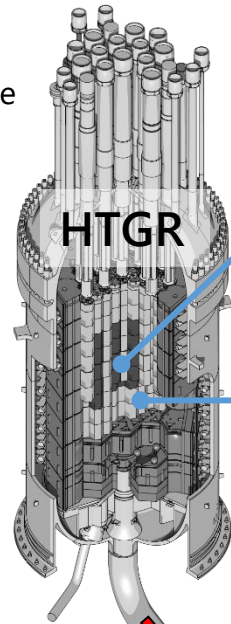
Launched time

1998

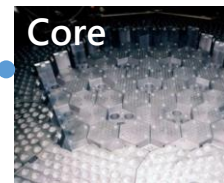
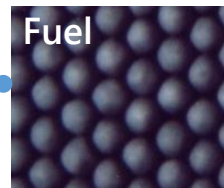
Overview

- HTGR (High-temperature gas-cooled reactor) shuts down and cools core in case of the black-out accident without any equipment or operator actions
- HTGR can supply up to 950°C of heat, which can be used for various applications such as H₂ Production, high efficient power generation
- IS process (thermochemical water-splitting H₂ production) can directly harness the heat from HTGR, which offers a large hydrogen supply and maximum energy security

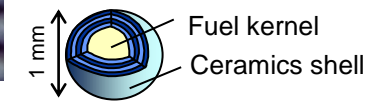
- Small particle fuels have **high ability to trap radioactive materials**
- Core melting must not occur due to its **high heat resistance temperature**
- Potentially, **hydrogen explosion does not occur** because of no water (hydrogen source)



HTGR technologies developed in Japan



Fuel
Each spherical shell traps radioactive nuclear fuel even above 1,600°C



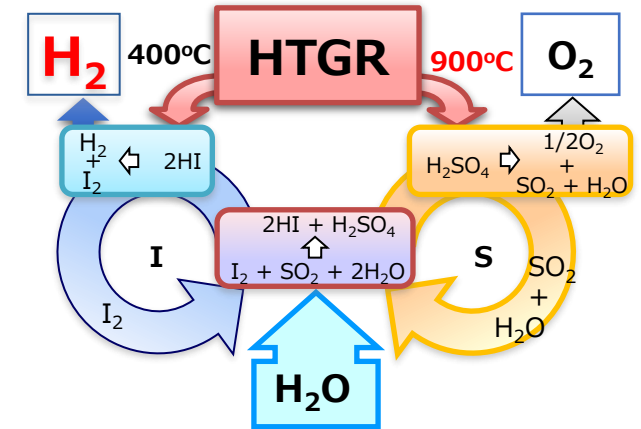
Core
Graphite structure has heat resistance of 2,500°C



Helium gas coolant
• Chemically stable

950°C

Carbon-free H₂ production under development in Japan Atomic Energy Agency



- IS process can decomposes H₂O using chemical reactions suitable for HTGR
- No CO₂ is produced because heat is supplied by HTGR

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Barriers on developing the innovation

- **HTGR**

Conforming to new regulatory with enhanced safety requirements for restarting HTTR to contribute the carbon neutrality



HTTR : A testing reactor to establish HTGR technologies constructed by JAEA

- **IS process**

Developing chemical reactors that can withstand high-temperature corrosive process environments. Solving corrosive fluid leakage due to equipment corrosion and pump malfunction caused by solidification of iodine

Success factors to overcome the above barriers

- **HTGR**

Since Nuclear Regulation Authority of Japan concluded that significant core degradation including core melting would not occur, HTTR restarted without significant additional reinforcements

- **IS process**

Developed chemical reactors from various heat-resistant corrosion-resistant materials. Improved quality control of corrosion resistant equipment manufacturing and the pump to prevent the solidification. Hydrogen production (30 L/h, 150 h) was successfully accomplished

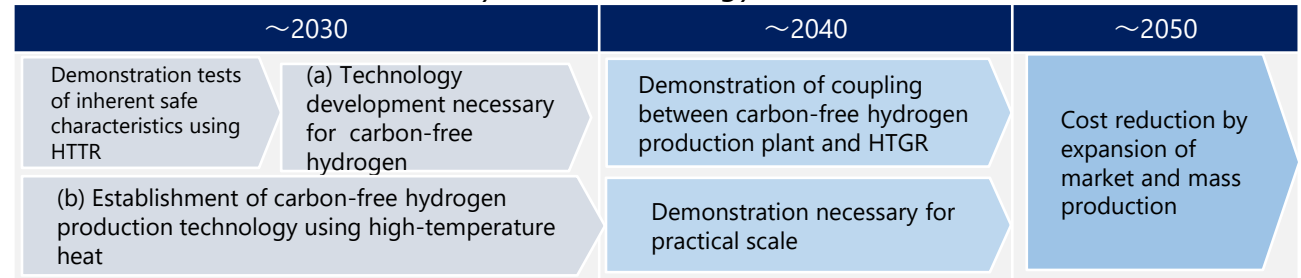
Source © JAEA (<https://www.jaea.go.jp/english/>)

Future action plan

- **Issue**

Since CO₂ emissions from the industrial sector such as steelmaking account for about 25% of the total emissions in Japan, large-scale /economical hydrogen supply are required* for the hydrogen-reduction steelmaking currently under development

Plans* for 2050 carbon neutrality in nuclear energy sector



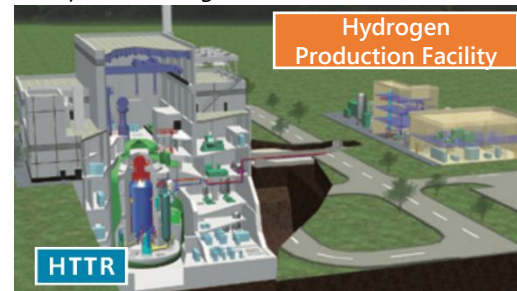
*Source: Website of METI

- **JAEA's efforts to solve the above issues**

(a) Developing connection technologies which have heat source and hydrogen production facility secured

(b) Making the prospect of technological feasibility of carbon-free hydrogen production methods

Conceptual drawing of HTTR-heat utilization test



Hydrogen production test apparatus of IS process

