H_2 production with superior-safety nuclear reactor

Organization

Japan Atomic Energy Agency (JAEA)

Launched time

1998

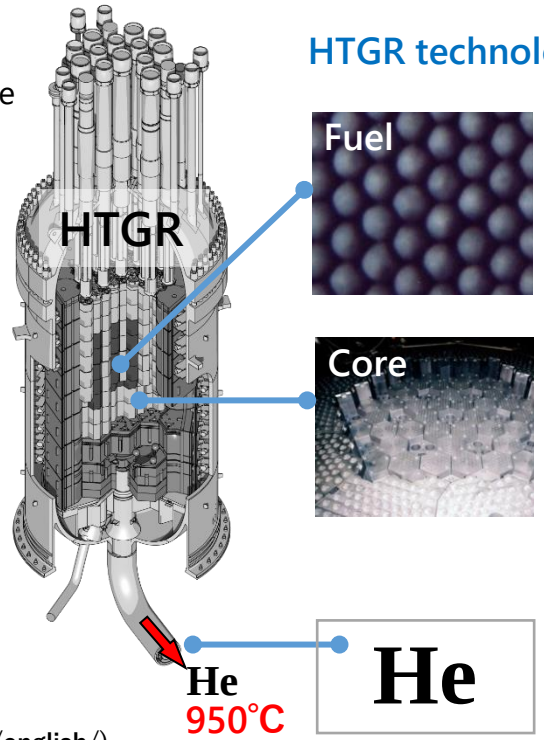
Overview

- 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℃ of heat, witch can be used for various applications such as H_2 Production, high efficient power generation
- IS process (thermochemical water-splitting H_2 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

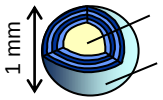
・Core melting must not occur due to its **high heat resistance** temperature

・Potentially, **hydrogen explosion does not occur** because of no water (hydrogen source)



HTGR technologies developed in Japan

Each spherical shell traps radioactive nuclear fuel even above 1,600℃



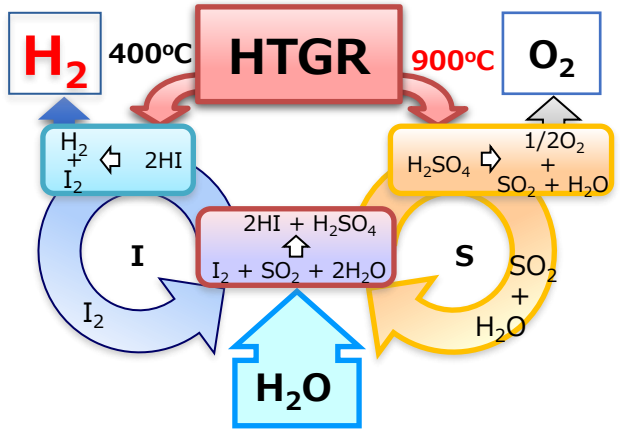
Graphite stricture has heat resistance of 2,500℃

He

Helium gas coolant

・Chemically stable

Carbon-free H_2 production under development in Japan Atomic Energy Agency



・IS process can decomposes H_2O using chemical reactions suitable for HTGR

・No CO_2 is produced because heat is supplied by HTGR

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

H_2 production with superior-safety nuclear reactor

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

Future action plan

- **Issue**

Since CO_2 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*

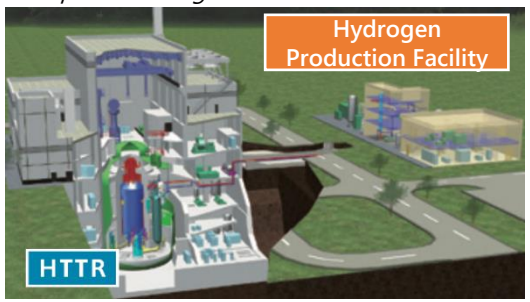
～2030	～2040	～2050
Demonstration tests of inherent safe characteristics using HTTR	(a) Technology development necessary for carbon-free hydrogen	Demonstration of coupling between carbon-free hydrogen production plant and HTGR
(b) Establishment of carbon-free hydrogen production technology using high-temperature heat		Demonstration necessary for practical scale
		Cost reduction by expansion of market and mass production

**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

Conceptual drawing of HTTR-heat utilization test



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

Hydrogen production test apparatus of IS process

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