Process Design of Cernavoda Tritium Removal Facility

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1. Introduction

Korea Hydro & Nuclear Power CO.,LTD(KHNP) has signed a contract worth KRW260 billion in June 2023 to construct a tritium removal facility(TRF) at Romania's Cernavoda nuclear power plant site.

The Cernavoda TRF is currently under construction with an planned completion date of 2027 and will be the third facility in the world after Canada's Darlington TRF(1990) and South Korea's Wolsong TRF(2007).

2. Process Design Description

The TRF will include several high-technology areas : liquid phase isotopic separation, cryogenic distillation and tritium storage.

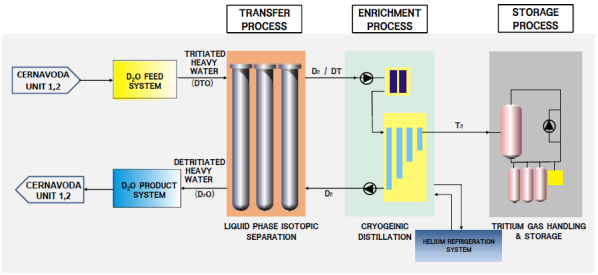

Figure 1. TRF Process Block Diagram

2.1. Liquid Phase Isotopic Separation(Transfer Process)

The first part, or front-end of process is to remove the tritium from the heavy water using catalytic exchange reaction. The detritiated heavy water is returned back to the reactor after being treated in this transfer process.

$$DTO + D_2 \xrightarrow{\text{catalyst}} D_2O + DT$$

Tritium is transferred from a heavy water molecule to a deuterium molecule under the wet proofed platinum catalyst. This process is termed liquid phase catalytic exchange (LPCE).

2.2. Cryogenic Distillation (Enrichment Process)

The second part of process concentrates the transferred tritium at front-end process. This process is operated a very low temperature for liquefying and distilling deuterium and tritium mixture (D_2/DT), to produce streams of essentially pure D_2 and T_2. The operating temperature of CD column is about 24~26 K.

This process consists of four cryogenic distillation columns. The helium refrigerator is operated for cooling this hydrogen isotope.

2.3. Tritium Gas Handling & Storage (Storage Process)

The final stage of process is the measurement and packaging of the concentrated tritium for secure long-term storage. Tritium concentrated from enrichment process is reacted with titanium metal in immobilized tritium container at room temperature, to form a stable metal tritide (TiT)

3. Comparison of CTRF, WTRF and DTRF Design

The typical design differences in the TRF process are as follows.

	CTRF(Romania)	WTRF(Korea)	DTRF(Canada)
D_2O Feed Rate	40 kg/hr	100 kg/hr	360 kg/hr
Catalyst Type	LPCE (Mixed Bed)	LPCE (Separated Bed)	VPCE*
Tritium Removal Rate	99%	97%	97%
Number of CD Column	4	4	4
Refrigerator	Helium	Helium	Hydrogen
Tritium Storage	Titanium Vessel	Titanium Vessel	Titanium Vessel
Tritium Purity in storage	≥99%	≥99%	≥99%
Operation Year	2027 (planned)	2007	1990

* VPCE : Vapor Phase Catalytic Exchange

4. Construction Organization

The employer for CTRF construction project is SNN (Nuclearelectrica National Company) in Romania. KHNP is prime contractor and undertake procurement of equipment and commissioning. The design company is KEPCO E&C. Construction work is carried out by HSJV(Hyundai-Samsung Joint Venture).

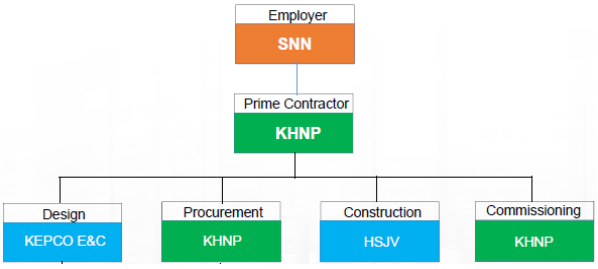

Figure 2. Construction Organization Structure

5. Conclusion

When CTRF is constructed, worker dose and environmental emissions of tritium will be significantly reduced. It is also expected to reduce tritium concentrations in order to facilitate the upcoming replacement of reactor refurbishment for Cernavoda Unit 1.

REFERENCES

[1] CTRF Plant and Design, 2022.