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Catalyst Loading and Installation of the LPCE Column for the Wolsong Tritium Removal Facility (WTRF)

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1. Introduction

A tritium removal facility (TRF) is under construction at Wolsong site. The overall function of the WTRF is to remove tritium from the heavy water systems of the CANDU6 reactors in operation at the Wolsong site. The front-end process of this facility is LPCE (liquid phase catalytic exchange), where the tritium is extracted from heavy water to deuterium gas phase. The LPCE system consists of two packed-bed columns, which have a special feature of separate catalyst and packing for two step exchanges between deuterium and tritium. In this study, the procedures and techniques for the catalyst loading, assembly of internals and installation of the LPCE columns are introduced.

2. Features of the WTRF LPCE Column

2.1 Overall features of the LPCE system

The tritium removal process of the WTRF is made up of three parts. The front-end process of the WTRF is LPCE process. In this process, the tritium is extracted firstly from the heavy water through catalytic reaction. The catalyst and column for the WTRF LPCE process had been developed by KEPRI and KAERI.

Table 1. The specification of the heavy water feed and product of LPCE system.

	Unit	Feed	Product
Flow Rate	Kg/hr	100	100
Isotopic Moderator Coolant	 % %	 99.8 98.5	 99.8 98.5
Tritium	Ci/kg	1-60	1/35 of feed
pH	-	7-10	7-10
TOC	ppm	0.5	0.5
COD	ppm	< 10	< 10
Oil	ppm	< 0.1	< 0.1
Particles	microns	< 100	< 100

The general design and performance specification of the WTRF LPCE system is given in Table 1. The capacity of the LPCE system is 100 kg/hr, and its detritiation factor per pass is 35. This design specification allows the WTRF to maintain the tritium activities in the moderators of four CANDU 6 reactors below 370 GBq/kg.

2.2 Configuration of the LPCE Columns

Each section of the LPCE columns consists of three parts: mass transfer packing bed, separate catalyst bed, and liquid distributor. The first column has 28 sections, a sump and a separate overhead condenser. The second column has 27 sections, a sump and a humidifier. The Sulzer CY packing for the vapor-liquid mass transfer is packed into the inner shell of each section and the wet proofed catalyst for the vapor-gas reaction is loaded into between the inner and outer shell. The liquid distributors are equipped on the Sulzer CY packing of each section.

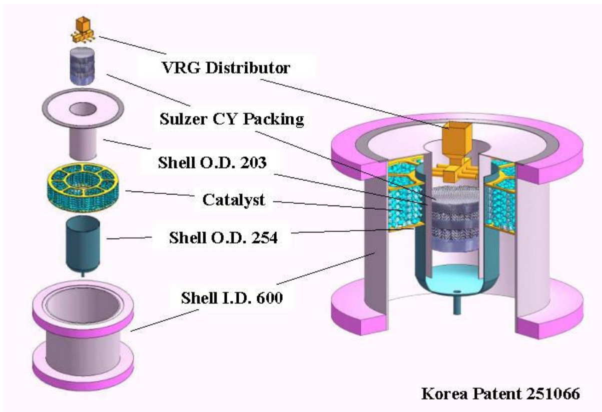


Figure 1. The internals of a catalyst section.

The specification of the LPCE columns is given in Table 2.

Table 2. The specification of the LPCE columns.

Type		Vertical Column
Diameter		0.6 m
Height		Column 1: 19.25 m Column 2 : 20.21 m
Number of Catalyst Section		55
Temperature	Design	125 ℃
	Operating	70~73.3 ℃
Pressure	Design	-100/1,000 kPa
	Operating	120~145 kPa

3. Assembly and installation of the LPCE Column

3.1 Assembly procedure of internals

The procedure for the internal assembly is as follows:

(1) Assembly of bottom mesh for the catalyst support.

(2) Catalyst loading between shell ID600 and OD254.
(3) Assembly of top mesh for the catalyst support.
(4) Assembly of a metal gasket.
(5) Assembly of Gas/Liquid sealing plate & inner pipe.
(6) Assembly of Sulzer CY64 packing.
(7) Assembly VRG Distributor (liquid distributor).

3.2 Catalyst loading

The catalyst is used for the reactive extraction of the tritium from heavy water vapor to deuterium gas phase. The catalyst is one of the key components of the LPCE process. The amount of about 30 liter catalyst per section is loaded. The first completion of catalyst loading in the section #55 of the LPCE Column-2 is shown in Figure 2.

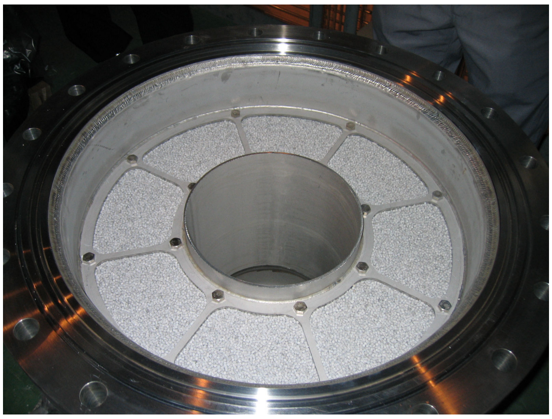
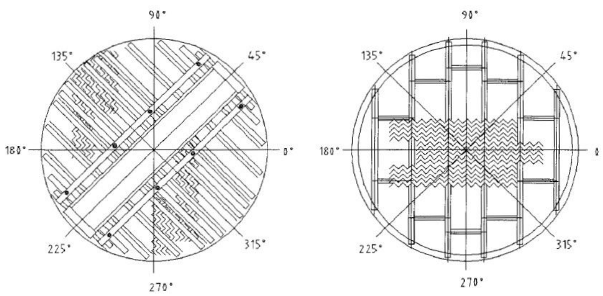


Figure 2. The first completion of catalyst loading in the section #55 of the LPCE Column-2.

3.3 Orientation and leveling of distributor and packing

The liquid distributor is the most important unit of internals for the vapor-liquid mass transfer. The objective of the liquid distributor is to uniformly distribute the heavy water over the cross-section of the Sulzer CY packing. So the orientation and vertical tolerance of the distributor is important. Figure 3 shows the orientation of the distributor and support grid to the packing layer.



(a) (b)

Figure 3. The orientation of the distributor (a) and support grid (b) to the packing layer.

The distributor on top of packing is oriented 45° to top layer of packing and the support grid at bottom of packing is oriented 90° to bottom layer of packing. Further, the distributors are positioned precisely aligned in the center of column and horizontally installed with leveling devices. These devices are either locating grids, leveling bars, jigs or suspension screw arrangements.

3.4 Vertical tolerance of the Column

The vertical tolerance is checked after the installation of each section. For proper operation of packing a maximum allowed vertically is to be kept. The verticality V is a function of the column height shown in Eq. (1). The horizontal difference x between column head and sump is verified.

$$V = \frac{x}{\text{column} \quad \text{height}} \times 100 \ \ [\%] \qquad (1)$$

The vertical tolerance of the LPCE column should be lower than 0.1% per section and 0.3% per total column height.

Figure 4. The vertical tolerance check of an installed section.

4. Conclusion and future work

The catalyst loading and installation of the LPCE columns is completed on the 22nd of April, 2006. The WTRF becomes the first commercial facility applying LPCE process for the tritium separation. According to the WTRF construction and commissioning schedule, the helium leak test and performance test of the LPCE column will be accomplished.

REFERENCES

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