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Disposal Cost Efficiency for the Four Alternatives

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1. Introduction

Spent fuel disposal system's performance improvement needs to consider mainly two aspects, which are the performance improvement from the safety aspect and the cost reduction from the economic aspect.

In Korea, four disposal alternatives were developed to this day in order to effectively carry out the direct disposal of the CANDU spent fuel. Disposal alternatives developed since 1997 are now at a state in which A-KRS-22 concept is developed after starting from the KRS (Korea Reference System). When the dominant characteristics of each alternative are examined, KRS-1 is based on the concept in which spent fuel is vertically emplaced to the granite located 500m below the ground level[3]. A-KRS-21 and AKRS-22 decreased the height of the disposal canister in order to emplace two disposal canisters in one disposal hole using the vertical emplacement.

Going forth, disposal alternative can be improved to dispose spent fuel more effectively[1, 2]. However, this research set the four disposal systems developed to this day, such as KRS-1, A-KRS-1, A-KRS-21 and A-KRS-22 as evaluation targets, to analyze the disposal cost efficiency of the unit module. These alternatives were listed in the order that they were developed.

2. Cost efficiency evaluation method

To evaluate disposal alternatives' efficiency from the cost aspect, it is necessary to calculate the cost of each disposal alternative.

As for the cost calculation method for the alternatives concerning each disposal system, there are two methods; method that entails calculating the total cost and the method in which only the cost that is consumed for the dominant cost driver is calculated[4].

2.1 Unit disposal module as the cost efficiency measure

This research seeks to calculate cost to identify the disposal cost efficiency by conducting cost analysis among disposal alternatives. In other words, this entails calculating quantitatively the cost of which alternative is reduced relatively compared to the other alternatives, and how much performance improves economically[5]. To calculate cost efficiency, alternative that serves as the standard for evaluation was set with the Korean Reference disposal System (KRS-1).

Moreover, dominant cost driver was drawn out based on the cost calculated based on the repository conceptual design of the KRS-1[6]. To compare the economic viability of each alternative, the cost evaluation measure used the unit disposal module concept. In other words, cost for the unit module that is comprised of the disposal tunnel and disposal hole for emplacing one disposal canister at the underground repository was set as cost efficiency evaluation measure to compare the disposal cost efficiency of each alternative as shown on Figure 1.

In addition, if there is severe price fluctuation when it comes to raw material cost like copper powder, which is the raw material for the disposal outer canister, it is rational to measure the efficiency with the volume of the raw materials consumed more than the cost in order to evaluate efficiency.

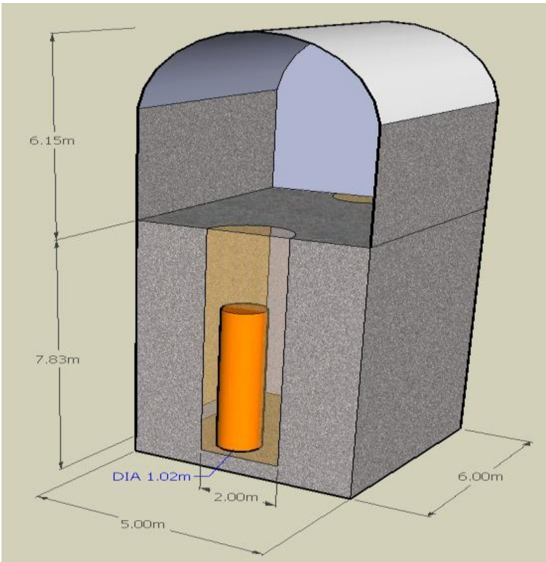

Figure 1. Concept of unit module

3. Results of the cost efficiency evaluation

When the overall cost reduction rate for the unit module of the four alternatives is examined using the KRS-1 as the standard, A-KRS-1 was -6.6%, A-KRS-21 was -27.3% and A-KRS-22 was -28.1%. However, effect for the cost concerning the dominant cost driver reduction for each bundle was calculated as shown from Table 1 to 2 to identify more detailed cost reduction rate.

Table 1. Canister cost of unit module

	KRS-1	A-KRS-1	A-KRS-21	A-KRS-22
Size[cm]	D 102 x H 483	D 124.4 x H 412.9	D 128 x H 274.5	D 128 x H 274.5
Weight of cast iron[kg]	15,825	8,440	7,445	7,445
Unit cost of cast iron[Eur/kg]	1.84	1.84	1.84	1.84
Cost of cast iron[Eur]	29,098	15,519	13,690	13,690
Unit cost of copper[Eur/kg]	7.52	34.05	34.05	34.05
Copper weight[kg]	7,229	1,830	1,234	1,234
Copper weight per bundle[kg/bundle]	24.3	4.4	5.1	5.1
Efficiency of copper reduction[%]	100	17.9	21.1	21.1

Table 2. Excavation cost of disposal hole for unit module

	KRS-1	A-KRS-1	A-KRS-21	A-KRS-22
Size[cm]	D 224 x H 783	D 225 x H 663	D 208 x H 799	D 208 x H 799
Volume[m^3]	31	26	27.1	27.1
Unit cost[Eur/m^3]	779.08	779.08	779.08	779.08
Excavation cost of disposal hole[Eur]	24,039	20,537	21,113	21,113
Efficiency[%]	100	85.4	88	88
Cost of disposal hole per bundle[Eur]	80.94	48.90	43.99	43.99
Efficiency of disposal hole per bundle[%]	100	60.4	54	54

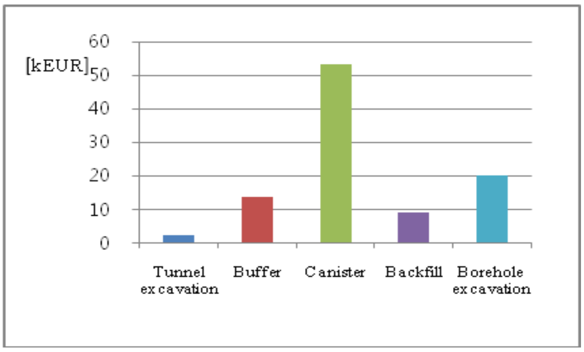

Figure 2. Dominant cost of unit module for A-KRS-22 alternative

When the dominant cost driver's cost for the unit module of the A-KRS-22 which was developed recently is shown in Figure 2, disposal canister's unit cost was highest with 53kEUR.

4. Conclusions

This research presented the result of calculating the disposal cost efficiency for the four disposal alternatives concerning the CANDU spent fuel that are under development in Korea today. The KRS-1 alternative, developed first was set as the standard, and efficiency of the KRS-1 alternative was assumed to be 100%.

The cost calculation result shows that the A-KRS-22, which was developed most recently among the CANDU spent fuel disposal alternatives, manifested -61.7%, -45.7%, -47.0%, -78.9% and -61.7% when compared to the KRS-1 alternative concerning disposal tunnel excavation, disposal hole excavation, bentonite, disposal canister and backfilling.

Moreover, the cost calculation method for the dominant cost driver that uses the unit disposal module concept for the calculation of cost efficiency was used. As for the reason that the standard for efficiency measurement was taken per each bundle, it is because the amount of bundle capacity concerning the spent fuel differs by disposal canister.

References

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