Depreciation cost for the capital investment of a pyroprocess facility

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1. Introduction

Currently, KAERI (Korea Atomic Energy Research Institute) operates the engineering-scale PRIDE (PyRoprocess Integrated inactive DEmonstration facility). In 2011, the conceptual design of the Korea Advanced Pyroprocess Facility Plus (KAPF+) was completed [1]. The pyroprocess produces U/TRU metal ingots using four important processes, pretreatment, electrochemical reduction, electrorefining and electrowinning, in order to recycle spent fuel. KAPF+'s capacity is shown on Table 1, and Table 2 shows the cost that is injected into the KAPF+.

Table 1. The capacity of KAPF+

Classification	Criteria
Capacity	Pretreatment: Spent fuel of 400 tHM/yr Temporary storage: 400 tHM/yr Pyroprocessing: 200 tHM/yr/module x 2 module

Table 2. The costs of KAPF+

Category	Discounted(5%) Amount (unit: k$)	Ratio (%)
Capital Investment	261,180	33.5
O&M (Operation and Maintenance) Cost	496,219	63.7
D&D (Decommission and Disposal) Cost	21,988	2.8
Total	779,386	100

The pyroprocess unit cost is data that are essential for inputting to calculate the pyroprocess-Sodium-cooled Fast Reactor (SFR) nuclear fuel cycle cost. Moreover, since the pyroprocess facility's depreciation cost is included in the manufacturing indirect cost of the pyroprocess cost, it can become an important element for judging the pyroprocess' economic viability.

Since the pyroprocess unit cost calculates the sum of the costs that are incurred each year by dividing with the total amount of U/TRU ingot produced, the pyroprocess unit cost uncertainty increases as well when the uncertainty of the costs incurred by each year increases.

An accounting method that can decrease the uncertainty of the capital investment that is injected into the pyroprocess facility every year during the pyroprocess facility's life period in order to factor into the pyroprocess unit cost.

2. Methods and Results

2.1 Depreciation Cost Calculation Method

2.1.1 Straight-line method

The straight-line method entails deducting the residual value from the purchasing cost, and then depreciating the same amount during each period. The straight-line method is suitable when the economic benefit is manifested in a consistent manner during the depreciation period as the time lapses by, and is expressed as Equation (1) [2].

$$DC_t^{SLM} = \frac{(PC_A - RV_A)}{N} \qquad (1)$$

where DC_t^{SLM} = depreciation cost of the straight-line method at year t, PC_A =the purchasing cost of tangible assets A, RV_A =the residual value of tangible assets, and N = durable period (unit : year).

2.1.2 Fixed percentage of declining-balance method

The fixed percentage of declining-balance method is for calculating the depreciation cost by multiplying a tangible asset's base book value amount by a specific rate for each period. Since the base book value amount is the residual amount after deducing the cumulative depreciation cost amount from the purchasing cost, the depreciation cost is recognized significantly in the beginning, and decreases as time passes. Moreover, a nonzero residual value needs to be assumed to avoid the depreciation rate of 1. This method can calculate the depreciation rate from Equation (2) [3], and the depreciation cost can be calculated using Equation (3).

$$DBRFP_A = 1 - \sqrt[N]{\frac{RV_A}{PC_A}} \qquad (2)$$

where $DBRFP_A$ = declining balance rate of tangible assets A.

$$DC_t^{FPDBM} = BV_A \times DBRFP_A \qquad (3)$$

where DC_t^{FPDBM} = the depreciation cost of the fixed percentage of declining-balance method at t year, and

BV_A = the book value of tangible assets A at the beginning of year.

2.1.3 Advanced Decelerated Depreciation Method (ADDM)

ADDM is a method that complements the existing sinking fund method. In other words, although the sinking fund method factors in the currency's time value, it is used to obtain the sinking fund. Toward this, the depreciation cost is calculated by obtaining the accumulated amortization's interest received. Thus, the sinking fund method is inappropriate for calculating the depreciation cost of the pyroprocess facility's tangible asset itself. Accordingly, this paper presents a new depreciation method called ADDM. To utilize ADDM, the purchasing cost for the pyroprocess facility's tangible asset factors in the currency's time value to be expressed, as in Equation (4).

$$DC_{t_0}^{ADDM} = \frac{(PC_A^B + PC_A^E)}{\sum_{n=1}^{N}(1+d_r)^{n-1}} \qquad (4)$$

where $DC_{t_0}^{ADDM}$ = the first-year depreciation cost of ADDM, PC_A^B = the purchasing cost of building A, PC_A^E = the purchasing cost of equipment A, N = durable period (unit : year), and d_r = the deceleration rate (discount rate).

Finally, depreciation cost of ADDM can be expressed as Equation (5).

$$DC_t^{ADDM} = (PC_A^B + PC_A^E) \times \frac{(1+d_r)^{t-t_0}}{\sum_{n=1}^{N}(1+d_r)^{n-1}} \qquad (5)$$

where DC_t^{ADDM} = the depreciation cost of ADDM at t year, and t_0 = the beginning year of depreciation.

2.2 Depreciation Cost Estimation Results

The depreciation costs of the three methods (straight-line method, fixed percentage of declining-balance method, and ADDM) are shown in Fig. 1 (durable period of 40 years).

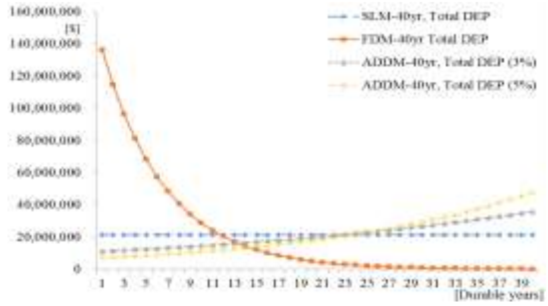

Fig. 1. A comparison of total depreciation costs with the durable period of 40 years

The depreciation cost for the first year on the basis of the straight-line method was calculated. The depreciation cost of the fixed percentage of the declining-balance method was 553.56%. In addition, the depreciation cost of ADDM that assumed a discount rate of 3% was 80.56%, whereas the depreciation cost of ADDM, which assumed a discount rate of 5% was 69.51%.

3. Conclusions

KAPF+, which is a commercialization facility, was set as the cost object, and the existing methods (straight-line method and fixed percentage of declining-balance method) used today and the depreciation cost of the ADDM were subjected to a comparative analysis. The results are as follows. First, in case of the straight-line method that calculated the durable period as 40 years, and in case of ADDM that factored in a 5% deceleration rate, the difference in the depreciation costs of $65.26/kgHM and $119.05/kgHM resulted during the first and last years, respectively. Accordingly, it was analyzed that there is a significant difference in terms of the cost of the capital investment every year depending on the depreciation method. Secondly, since the depreciation cost is a component of the manufacturing indirect cost, it is necessary to maintain a trend that is similar to that of the direct labor cost in addition to the direct material cost. From this respect, the depreciation cost of ADDM can be considered the most suitable depreciation method for a pyroprocess facility. In the end, the depreciation cost of ADDM that assumed a durable period of 40 years and a deceleration rate of 5% was found to take up 4.14% and 27.74% during the first and last years among the pyroprocess unit costs ($781/kgHM [4]).

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