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The Selection of the economical optimum product in pressurized Hollow Fiber Membrane (PHFM) Modules in Purification System, through Risk-based Life Cycle Cost (LCC) by using a Poisson's Failure Probability model.

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ABSTRACT

The pressurized hollow fiber membrane (PHFM) modules in Y water treatment utility (YWTU) in Korea was required for the replacement of modules within a few years through analysis results through the Asset management method. It is necessary to evaluate Risk-based LCC (RbLCC) to select the optimum product in the economical side of Operation and Maintenance (O&M) in the practical field. We determined the optimum one in YWTU's specific O&M circumstances among possible products. When Pin-repairing PHFM / Total PHFM on the module is exceed over 0.45%, this excessive spot was determined as PHFM module' life span through the Pin-repairing Database. The life span was used into a factor of its failure in Poison model, which calculated how much the failure probability was happened by the operating time. Evaluating RbLCC was calculated by combining the initial cost and the value at risk without its warranting term. Both RbLCC and properties of membrane among 6 products were compared to select the optimum product, respectively. Results showed that the module's life span in the system was determined as 10 years (120 month) under the safety considerations. The optimum product becomes the H. Company's, because its RbLCC is 3rd rank as 497,067,000 (KRW). Although the A. Company's is the 1st rank as 434,637,000 (KRW) and the W. Company's is the 2nd rank as 479,303,000 (KRW) in RbLCC, they need additional costs to change its initial system. Therefore, YWTU's optimum product is selected as the H. Company's product.

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1. Introduction

Infrastructure's asset management in these field (Alegre H. 2007), such water treatment utility, water networks and other facilities became important because there is a tendency that developed governments' budget pressures rapidly increased in maintenance costs due to aging of infrastructure utilities, which came to requirement to manage effectively these aging utilities for reducing its replacement cost on the recovering its ability (Park S. 2016). The asset management is a way to maintain the valuation of infrastructures on base of the triple-bottom-line thinking that integrates social, environment, and economic responsibilities (Gimenez 2012).

Since, particularly in Korea, water treatment utilities did often not have an enterprising to make enough black profits to prepare its renewal fund of facilities, these utilities need to prepare efficiently either their strategy to replace their aging facilities with new ones, or to minimize their maintenance costs through analyzing quantitative value at risk and life cycle cost in the asset management for sustainable enterprises (Strazza 2015).

In the recent study for YWTU in Korea, using PHFM modules, was required for the replacement of using modules within a few years (Lee C. 2016), which resulted from analyzing the database of both operation and maintenance. Since this requirement to exchange whole active modules in YWTU, it was necessary to conclude a reasonable judgment in the process of decision-making on following questions; whether repurchasing the active modules is a better economical remedy, or buying different types of the modules are more reasonable economically than the former. The chosen product will be used for a long time above 5 years and be difficult to exchange one to other products in the short time, when a certain type of PHFM modules is both selected and installed as the counterplan in the operation of the system. Thus, the administrators took into consideration of evaluating both its initial purchasing cost and its value at risk, which is stochastically happened on the failure modules dependent on its physical deterioration as usage time goes on.

According to the perspective, the RbLCC, considering together both the initial purchasing cost and the value at risk, can become important in the process of decision-making (Jo H. 2009). Since comparing RbLCC results on individual products for use time in YWTU, managers can take an advantage of doing the proper rational decision to select an optimal product economically as the optimum in all alternatives.

The objective of this paper is therefore to select the optimum product through performing the risk assessment about possible candidates in a way that evaluates individual RbLCCs and compares its results in economical view to minimize the replacement cost, based on the actual O&M database in YWTU.

2. Materials and methods

2.1. Properties of PHFM and Module

The properties of PHFM, being used in YWTU, are following as that; its material is PVDF (Polyvinylidene Fluoride), its micro pore size is 0.05 μm, and inner size in PHFM is 0.07 mm, outer size is 1.3 mm with asymmetrical structure. Its average