Replacement

Book : ***Plant Design and Economics for Chemical Engineers*****, M.S. Peters and K. D. Timmerhaus**

Chapter 10 (4th Edition)

The term "***replacement***," refers to a special type of alternative in which facilities are currently in existence and it may be desirable to replace these facilities with different ones.

The reasons for making replacements can be either of these two:

1. An existing property ***must*** be replaced or changed in order to continue operation and meet the required demands for production. The need for this type of replacement may be due to:

   (a) The property is worn out and can give no further useful service

   (b) The property does not have sufficient capacity to meet the demand placed upon it

   (c) Operation of the property is no longer economically feasible as the property has become obsolete

2. An existing property is capable of yielding the necessary product or service, but more efficient equipment or property is available which can operate with lower expenses.

Methods of Profitability Evaluation for Replacements

- When the reason for a replacement is the first one (mentioned in previous slide), alternative investments are compared and a final economic analysis is made
- In order to determine whether or not a replacement is advisable, the operating expenses with the present equipment must be compared with those that would exist if the change were made
- Practical considerations, such as amount of capital available or benefits to be gained by making the change is also considered
- Replacement analyses can be done using the same methods used for studying alternative investments
- ***Net-present-worth*** and ***discounted-cash flow methods*** give the soundest results for maximizing the overall future worth of a concern.
- However, for the purpose of explaining the ***basic principles*** of replacement economic analyses, the simple ***rate-of-return-on-investment method*** is just as effective as those methods involving the time value of money.

An example to illustrate the type of economic analysis involved in determining whether a replacement should be made

A company uses a piece of equipment which originally costs $30,000. The equipment has been in use for 5 years, and it now has a net realizable value of $6000. At the time of installation, the service life was estimated to be 10 years and the salvage value at the end of the service life was estimated to be zero. Operating costs amount to $22,00O/year. At the present time, the remaining service life of the equipment is estimated to be 3 years.

A proposal has been made to replace the present piece of property by one of more advanced design. The proposed equipment would cost $40,000, and the operating costs would be $15,0OO/year. The service life is estimated to be 10 years with a nonzero salvage value.

Each piece of equipment will perform the same service, and all costs other than those for operation and depreciation will remain constant. Depreciation costs are determined by the straight-line method.

The company will not make the replacement unless it can obtain an annual return on the necessary capital of at least 10 percent.

There are, thus, two options in front of the company – either to continue with the use of the present equipment or to make the suggested replacement. The company has to choose the better alternative by considering both the reduction in expenses because of the change and the increase in the amount of new capital necessary

The variable expenses for the two options are those for operating cost and depreciation.

Depreciation cost of the new equipment $= \frac{40{,}000 - 0}{10} = \$\ 4000$

Annual variable expenses for the new equipment = Annual operating costs + Depreciation = \$15,000 + \$4,000 = \$19,000.

The net realizable value (present worth) of the existing equipment = \$6000.

(In order to make a fair comparison between the two alternatives, all costs must be based on conditions at the present time)

Depreciation cost of the old equipment $= \frac{6{,}000 - 0}{3} = \$\ 2000$

Annual variable expenses for the old equipment = Annual operating costs + Depreciation = \$22,000 + \$2000 = \$24,000.

An annual saving of (\$24,000 - \$19,000 = \$5000) can be made by making the replacement.

The cost of the new equipment is \$40,000, but the sale of the existing property would provide \$6000; therefore, the extra investment = \$40,000 - \$6,000 = \$34,000

Therefore, return on investment (ROI) = $\frac{5000}{34000} \times 100 = 14.7\%$

Since ROI > minimum acceptable annual return (10%), the replacement is recommended

Factors to be considered for replaceability analysis

- Net realization value of an existing property can be assumed to be the market value
- Book value = Initial cost of property – depreciation charged up to that point
  - In the previous example, the book value of the equipment after 5 years
$$= 30{,}000 - 5 \times \left(\frac{30{,}000-0}{10}\right) = \$\ 15{,}000$$
  - But the net realizable value of the equipment was only $6000
- The difference between the book value and the net realizable value at any time is designated as the ***unamortized*** value.
  - In the example, the unamortized value was $15,000 - $6000 = $9000
- The book value is based on past conditions but replacement decisions must be based on present conditions, and hence, based on net realizable value and not book value
- In replacement studies, the ***net realizable value*** of an existing property should be assumed to be the market value.

- The decision whether to make a replacement or not is usually determined by the *rate of return* which can be estimated from the necessary investment. It is, therefore, important to consider the amount of the investment. ***The amount of necessary investment is the difference between the total cost of the replacement property and the net realizable value*** **of** ***the existing property***
- All the previous statements are based on the theoretical viewpoint of alternative investment and replacement studies. However, certain practical considerations also play a role before the final decision is made
- In many cases, the amount of available capital (money for investment) is limited. In case of alternative investment (or replacement), although a greater investment might be better on a theoretical basis, the additional return may not be worth the extra risk involved when capital must be borrowed or obtained from some other outside source
- Sometimes, economic conditions existing at the particular time have an important practical effect on the final decision. In depression periods or in times when economic conditions are very uncertain (such as the current world situation), it may not be advisable to invest any more capital than what is absolutely necessary
- Final decision about alternate investments and replacements depend on theoretical results plus practical factors

Example

The owner of a small antifreeze plant has a small canning unit which cost him $5000 when he purchased it 10 years ago. The unit has completely depreciated, but the owner estimates that it will still give him good service for 5 more years. At the end of 5 years the unit will be worth a junk value of $100. The owner now has an opportunity to buy a more efficient canning unit for $6000 having an estimated service life of 10 years and zero salvage or junk value.

This new unit would reduce annual labour and maintenance costs by $1000 and increase annual expenses for taxes and insurance by $100. All other expenses except depreciation would be unchanged.

If the old canning unit can be sold for $600, what replacement return on his capital investment will the owner receive if he decides to make the replacement? Is the replacement advisable if the minimum return on investment required is 15%?

Old canning unit

Original value (V)= $600 Salvage value ($V_s$) = $100 n = 5 years

Depreciation (d) = $\frac{V-V_S}{n} = \frac{600-1}{5} = \$100/year$

New canning unit

Original value (V)= $6000 Salvage value ($V_s$) = $0 n = 10 years

Depreciation (d) = $\frac{V-V_S}{n} = \frac{6000-0}{10} = \$600/year$

Decrease in depreciation cost because of replacement = $600 - $100 = $ 500/year

Decrease in maintenance and labour = $ 1000/ year

Increase in insurance and taxes = $ 100/ year

Total savings using new unit = $1000 -$500 - $100 = $400/ year

Net investment = $6000 - $600 = 5400

Return on investment (ROI) = $\frac{400}{5400} \times 100 = 7.41\%$

Since ROI < minimum acceptable annual return (15%), the replacement is not advisable