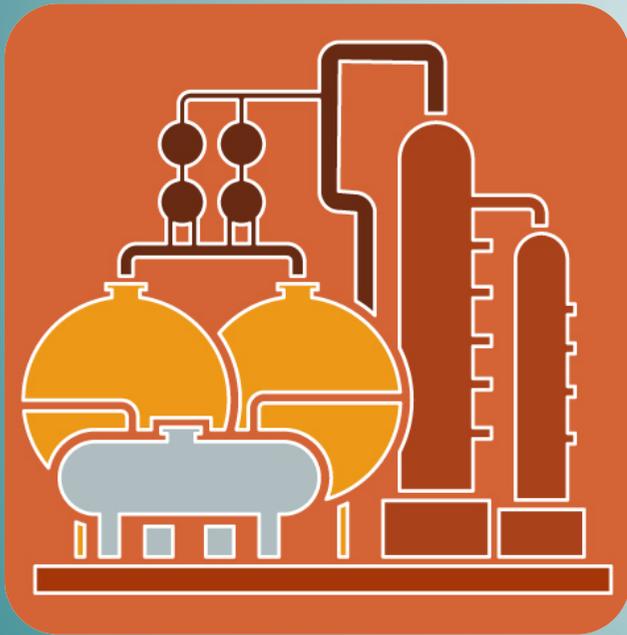


Chemical Process Design / Diseño de Procesos Químicos

Topic 6.3. Economic Indicators



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PRACTICAL CHAPTER

RELEVANT TO LEARNING

5.- Simple Estimate Earnings and Returns

- **Earnings:**

- **Pre-tax earnings or Gross earnings or Profit = $S - C$**

S: Annual sales revenue; **C:** COM, Manufacturing Costs.

- **After-tax earnings or Net earnings or Profit = Gross earnings – Income taxes on the gross earnings = $(1 - t)$ Gross earnings = $0.6 (S - C)$.**

t: Income tax rate = **A** constant value according to the local law.

- **Cash Flow (CF) (*Flujo de Caja*) and Depreciation (D):**

- **Cash flow = Net passage of money into (+) or out of (–) a company due to an investment → *Liquidez de la compañía*.**

Investment → (–) cash flow **After-tax profits + depreciation** → (+) cash flow.

- **Annual CF for any year of the project**

$$CF = \underbrace{0.6 (S - C) + D}_{\text{CF plant operation}} - \underbrace{fC_{TDC} - C_{WC} - C_{land}}_{\text{CF plant construction}} - C_{startup} - C_{royal} + S_{equip}$$

D: depreciation, decrease in value of an asset over time (use, obsolescence, old age).

f: fraction of the total depreciable capital (C_{TDC}) (buildings, equipment, machinery, intangibles...).

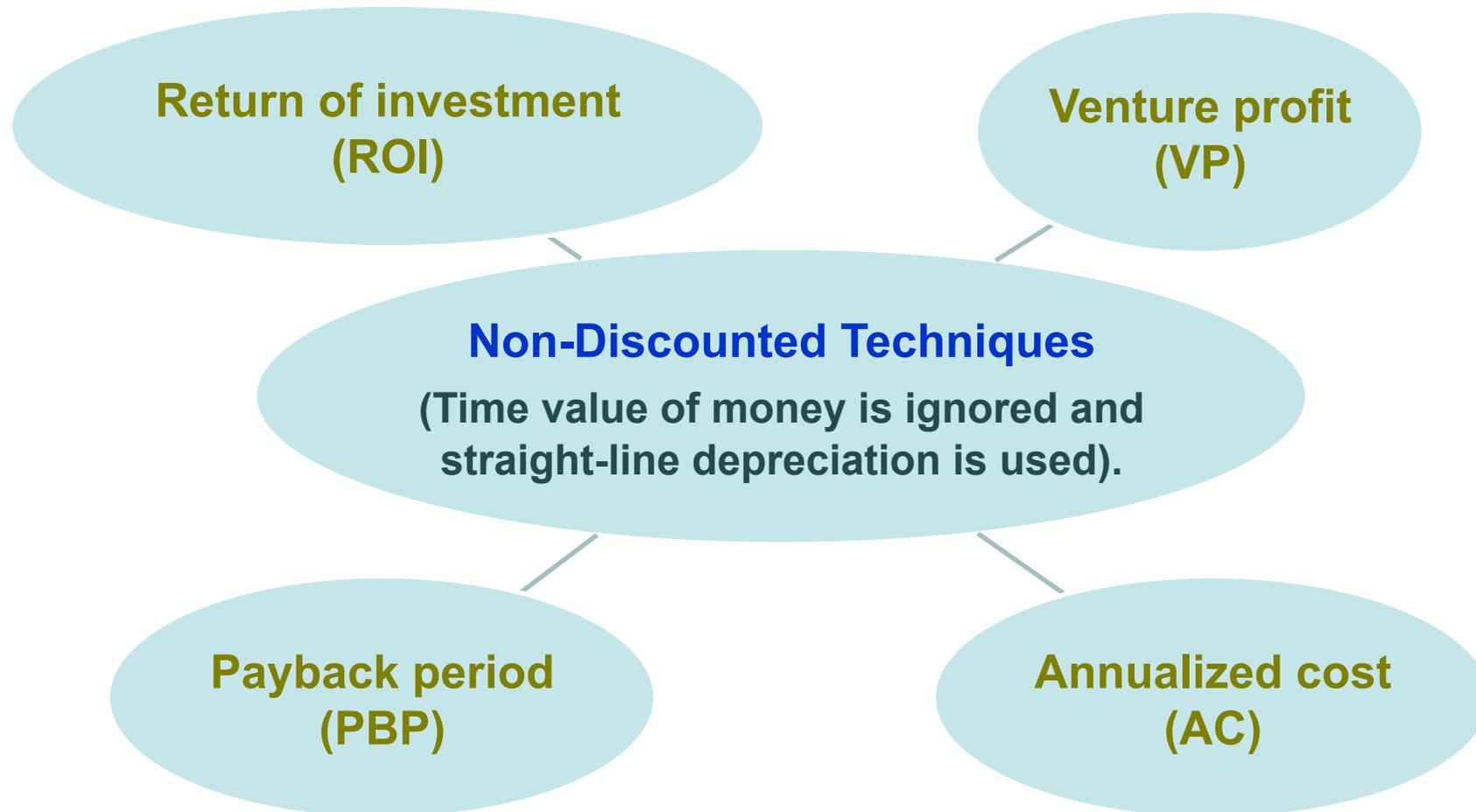
C_{WC} : working capital; **C_{land} :** cost of land expended during the year of construction.

$C_{startup}$: startup costs; **C_{royal} :** cost of royalties.

S_{equip} : salvage value for used equipment.

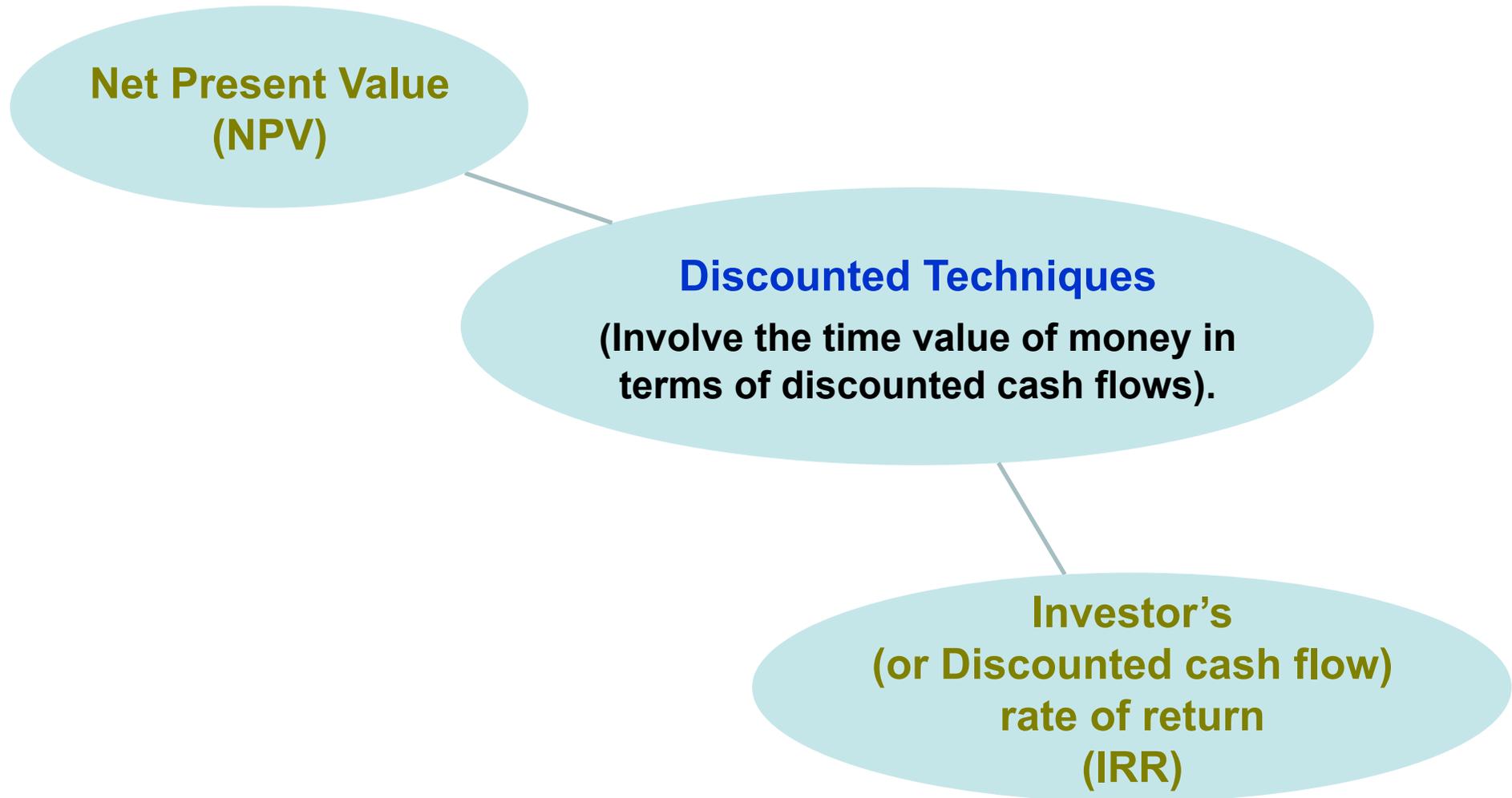
6.- Profitability Measures

Approximate Profitability Measures: useful in the early stages of project evaluation. New small projects or revamping (*renovación*).



6.- Profitability Measures

Rigorous Profitability Measures: Useful before a final decision is made on whether to proceed with a new venture.



6.- Profitability Measures

Non-discounted criteria: Based on time:

- Payback, Payout, Payoff period (PBP) / (*Periodo de Retorno*).



- Time required for the annual earnings to equal the original investment.
- $\text{PBP (years)} = \text{Total Depreciable Capital (€)} / \text{Net earnings} + \text{annual depreciation (€ / year)} = C_{\text{TDC}} / (1 - t) (S - C) + D.$



- $\text{PBP} < 3 - 4 \text{ y} \rightarrow \text{Profitable};$
 $4 < \text{PBP} < 10 \text{ y} \rightarrow \text{Additional assessment};$
 $\text{PBP} > 10 \text{ y} \rightarrow \text{Non-profitable}.$



- **“Useful in early evaluations to compare alternatives”.**

6.- Profitability Measures

Non-discounted criteria: Based on interest rate:

- Return of Investment (ROI) / (*Retorno de la Inversión*).



- Annual interest rate made by the profits on the original investment.
- $ROI (\%) = \text{Net earnings} / \text{Total Capital Investment} = (1 - t) (S - C) / C_{TCI}$.



- $ROI > 15\% \rightarrow$ Profitable.



- **“Provides a snapshot view of the profitability of the plant”.**

6.- Profitability Measures

Non-discounted criteria: Based on interest rate:

- Annualized Costs (C_A).



- Sum of the production cost and a reasonable return on the original capital investment where the reasonable return on investment, i_{\min} is 0.2.
- $CA = C + i_{\min} C_{TCl}$.



- “Useful to comparing alternative items of equipment in a process or alternative replacements for existing equipment”.

6.- Profitability Measures

Non-discounted criteria: Taking into account the size of the project:

- Venture profit (VP).



- Annual net earnings in excess of a minimum acceptable return of investment, i_{\min} (20%).
- $VP = (1 - t) (S - C) - i_{\min} C_{TCl} = \text{net earnings} - i_{\min} C_{TCl}$.



- **“Preliminary estimates when comparing alternative flowsheets during process synthesis”.**

6.- Profitability Measures

Discounted criteria:

- The “**time value of money**” refers to an amount of money at the current time, **Present amount, P**, that is invested at an **interest rate, i**, and the resulting amount of interest is added to P giving a **Future amount, F, ≠ P**.

$$F = P (1 + i)^n$$

- **Changes in the time value of money are due to:**
 - **INTEREST**, annual rate at which money is returned to investors for use of their capital.
 - **RETURNS** of competitor investments; thus the actual investment must compensate for investment opportunities not pursued in other businesses.
 - **INFLATION** or change in the value of a currency over time.

6.- Profitability Measures

Discounted criteria:

- Net Present Value (NPV) / Valor Actual Neto (VAN).



- Sum of all the discounted cash flows computed for each year of the projected lifetime (n) of the plant, including construction + startup.



- $NPV = [\text{Gross earnings} \times (1 - (1 + i)^{-n}) / i] - \text{Capital investment}.$



- **“Provides a quantitative measure for comparing the capital required for competing processes in current terms”** – it is an indicator of the value or magnitude of an investment.

6.- Profitability Measures

Discounted criteria:

- **Investor's Rate of Return (IRR) or Discounted Cash Flow Rate of Return (DCFRR).**



- **Interest rate that gives a net present value of zero. Interest rate that can be compared with a competing investment.**
- **$NPV \{i\} = [\text{Gross earnings} \times (1 - (1 + i)^{-n}) / i] - \text{Capital investment} = 0.$**



- **Used to evaluate the desirability of investments or projects. It is an indicator of the efficiency, quality, or yield of an investment. An investment is considered acceptable if its IRR is greater than an established minimum acceptable rate of return or cost of capital. **The largest IRR is the most desirable.****



- **“NPV and IRR are effective measures especially when the alternatives have widely disparate investments.**

6.- Profitability Measures

Viguri (et al.) (2000): «Design of waste minimization alternatives: application of criteria».

Viguri, J. (2000): «Environmental situation of the SME in Cantabria: minimization of the environmental impact».
Final Inform. Project from the enterprise development initiative. Santander, Spain. Septiembre 2000.

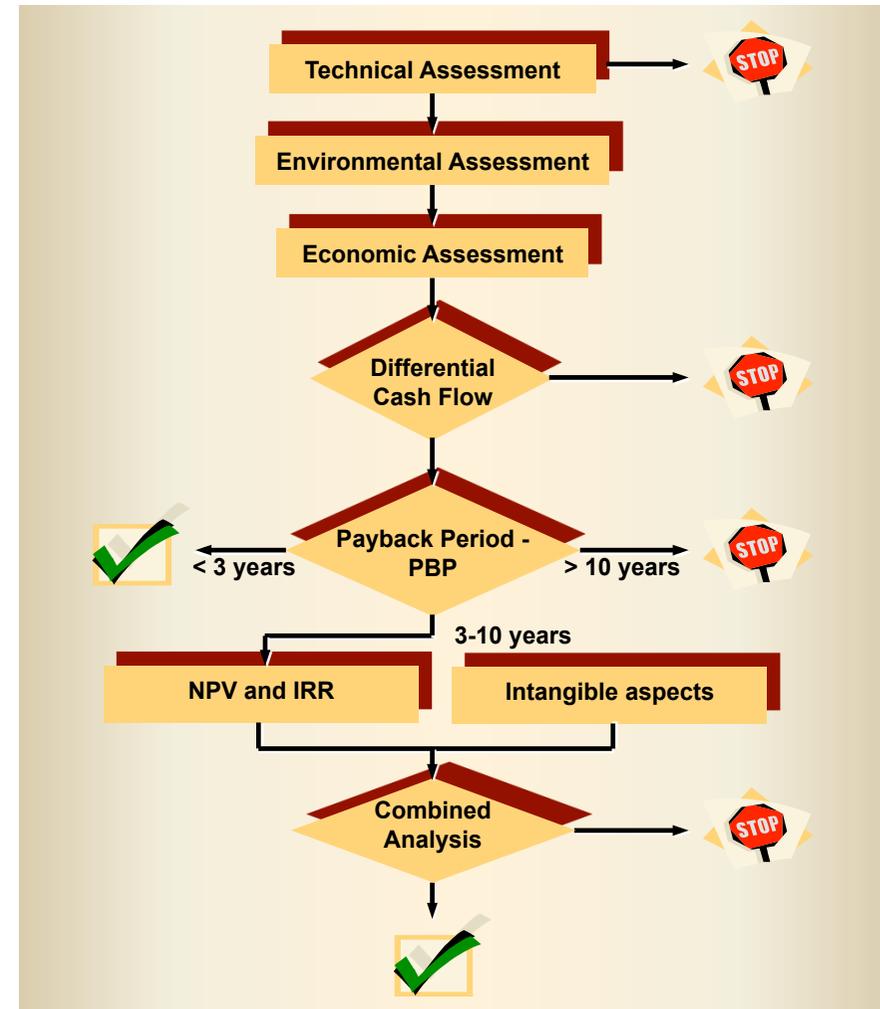


Figure. Suitability analysis of the minimization options.

Memo 3 are to size the equipment of the flowsheet, perform heat integration, and an economic evaluation.

7.- Further Reading and References

- Biegler, L.; Grossmann, I. & Westerberg, A. (1997): «*Systematic methods of chemical process design*». Prentice Hall.
- Douglas, J.M. (1988): «*Conceptual design of chemical processes*». McGraw-Hill.
- Peter, M.; Timmerhaus, K. & West, R. (2005): «*Plant design and economics for chemical engineers*». 5^a Ed. McGraw-Hill.
- Seider, W.; Seader, J.; Lewin, D. & Widagdo, S. (2010): «*Product and process design principles. Synthesis, analysis and evaluation*». 3rd Ed. John Wiley & Sons.
- Turton, R.; Bailie, R.; Whiting, W. & Shaeiwitz, J. (2003): «*Analysis, synthesis and design of chemical processes*». Prentice Hall.

PRACTICAL CHAPTER

- **Estimation of costs and profits applied to the case study and examples.**
- **Estimation of costs of your process design project.**
- **Estimation of profits of your process design project.**

RELEVANT TO LEARNING

- Categories of cost; unit of each; components of each category of cost.
- Why *Annualized Total Capital Costs* = $CT / 10 (1.15)^{10} = 4 \cdot BC$ [€/ year].
- Why $COM = 0.304 BMC + 2.73 C_{OL} + 1.23 (C_{UT} + C_{WT} + C_{RM})$.