# 

**ECONOMIC ANALYSIS**

## Total Capital Investment

Total capital investment is basically the sum of fixed-capital investment (FCI) and the working capital (WC). Usually, most estimation of capital investments are based on the cost of equipment required. Therefore, based on the equipment purchased cost, and indirect cost, estimation of total capital investment can be done.

Table 6.1: List of equipment and costing

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Process Area | Equipment | Quantity | Unit Cost (USD) | Total cost (USD) |
| Pre-treatment | Homogenizer | 2 | 114000 | 228000 |
| Stream explosion | 4 | 426000 | 1704000 |
|  | Enzymatic reactor  Storage tank | 6  3 | 1002000  210000 | 6012000  630000 |
| Fermentation | Seed Culture Tank | 1 | 706000 | 706000 |
| Fermentation Tank | 1 | 2321000 | 2321000 |
| Purification and recovery | Ultra-filter | 10 | 139000 | 1390000 |
| Holding tank  Stripper  Condenser | 2  1  1 | 171000  2000  36000 | 342000  2000  36000 |
| Distillation Column | 3 | 43000 | 129000 |
| Storage Tank | 4 | 53000 | 212000 |
| Equipment | Pump  Heat sterilizer | 5  1 | 2200  572000 | 11000  572000 |

**Table 6.1:** Continued

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Waste treatment | Trickling filter  Sedimentation tank  Grit chamber  Chlorination chamber | 1  2  1  2 | 2400  1000  50000  1000 | 2400  2000  50000  2000 |
| **Total =** | | | | **14351400**  **=RM55109376**  **(1 USD= 3.84MYR)** |

The costs of the purchased and installed equipment are based on the design report from the superpro.

## Estimation of total capital investment

Table 6.2 shows the total capital investment of the project after included the cost of waste.The indirect costs are estimated using factors based on delivery equipment. The total capital investment is equal to the sum to total direct cost and total indirect costs. As for waste treatment part, based on the amount of waste generated which is around 58207 kg/ batch, the installed cost of waste treatment plant is estimated to be 0.07 million $ according to the appendix B-9. This will be contributed to the purchased equipment installation.

Table 6.2 The total capital investment of ABE production.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Fraction delivered equipment  Fluid processing plant | | | Calculated values, $ million | |
|
|
|
| **Direct Costs** | | | |  | |
| Purchased equipment, E' | |  | | **14.351** | |
| Delivery, fraction of E' | | 0.10 | | 1.435 | |
| Subtotal: delivered equipment | |  | | 15.787 | |
| Purchased equipment installation | | 0.47 | | 7.461 | |
| Instrumentation&Controls(installed) | | 0.36 | | 5.683 | |
| Piping (installed) | 0.68 | | | 10.735 | |
| Electrical systems (installed) | 0.11 | | | 1.737 | |
| Buildings (including services) | 0.18 | | | 2.842 | |
| Yard improvements | 0.10 | | | 1.579 | |
| Service facilities (installed) | 0.70 | | | 11.052 | |
| Total direct costs | 2.60 | | | 56.873 | |
| **Indirect Costs** | | | |  | |
| Engineering and supervision | 0.33 | | | 5.210 | |
| Construction expenses | 0.41 | | | 6.472 | |
| Legal expenses | 0.04 | | | 0.631 | |
| Contractor's fee | 0.22 | | | 3.473 | |
| Contingency | 0.44 | | | 6.946 | |
| Total indirect costs | 1.44 | | | 22.733 | |
| **Fixed capital investment (FCI)** | | | | **79.605** | |
| **Working capital (WC)** | | | 0.89 | | **14.050** |
| **Total capital investment (TCI)** | | | | | **93.656** |

## Variable operating costs

The variable operating cost include raw material cost, utilities, labour cost, total annual production and the estimate of revenue. The calculation of the variable operating costs is are shows in the Table 6.3 to Table 6.7 and the cumulative cash flow graph is shows in Figure 6.1.

Table 6.3: Raw material cost.

|  |  |  |  |
| --- | --- | --- | --- |
| **Raw Materials** | | | |
| Name of Material | Price, $/kg | Annual Amount, million kg/y | Annual raw materials cost, million $/y |
|
|
|
| EFB | 0.01 | 16.454 | 0.16 |
| Clostridium Sp. | 1.00 | 0.049 | 0.05 |
| Yeast Extract | 1.00 | 0.009 | 0.01 |
| Tryptone | 1.00 | 0.027 | 0.03 |
| Ammonium acetate | 1.00 | 0.013 | 0.01 |
| Monopotassium Phosphate | 1.00 | 0.002 | 0.00 |
| Iron(II) SulfateHeptahydrate | 0.50 | 0.000 | 0.00 |
| Nitrogen gas | 20.00 | 0.014 | 0.29 |
| cellulase | 10.00 | 0.131 | 1.31 |
| Magnesium SulfateHeptahydrate | 0.08 | 0.001 | 0.00 |
| **Total annual cost of raw materials =** | | | **1.86** |

Table 6.4: Utilities.

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Price per units (USD) | Annual utility requirement, in appropriate units | Total (USD million/year) |
| Electricity | 0.045/kWh | 1000000 | 0.045 |
| Water consumption | 0.08$/m3 | 50000 | 0.004 |
| Wastewater treatment | 0.53$/ m3 | 50000 | 0.027 |
| Waste disposal: |  |  |  |
| Non-hazard | 36$/1000kg | 100 | 0.004 |
|  |  | Total | **0.079** |

Table 6.5: Labour cost

|  |  |  |  |
| --- | --- | --- | --- |
| Number of operators per shift | Shift per day | Operator rate, $/hr | Annual labor cost  ($ million/year) |
| 8 | 3 | 5 | **0.350** |

Table 6.6: Total annual production costs.

|  |  |
| --- | --- |
| Item | Cost, million $/y |
|
|
| Raw materials | 1.860 |
| Operating labour | 0.350 |
| Operating supervision | 0.053 |
| Utilities | 0.079 |
| Maintenance and repairs | 4.906 |
| Operating supplies | 0.736 |
| Laboratory charges | 0.053 |
| Royalties (if not on lump-sum basis) | 0.164 |
| Catalysts and solvents | 0.000 |
| **Variable cost =** | **8.201** |

**Table 6.6:** Continued

|  |  |
| --- | --- |
| Taxes (property) | 1.635 |
| Insurance | 0.818 |
| **Fixed Charges =** | **2.453** |
| Plant overhead, general | 3.186 |
| **Manufacturing cost =** | **13.839** |
| Administration | 1.062 |
| Distribution & selling | 0.819 |
| Research & Development | 0.655 |
| **General Expense =** | **2.536** |
| **TOTAL PRODUCT COST WITHOUT DEPRECIATION *= co =*** | **16.375** |
|

Table 6.7 Estimation of revenue.

|  |  |  |  |
| --- | --- | --- | --- |
| Products, Co-products and By-products | | | |
| Name of Material | Price, $/kg | Annual Amount, million kg/y | Annual value of product, million $/y |
| Acetone | 10.00 | 0.900 | 9.00 |
| Butanol | 35.00 | 1.800 | 63.00 |
| Ethanol | 10.00 | 0.300 | 3.00 |
|  |  |  |  |
| Total annual value of products= | | | 75.00 |

**Figure 6.1** Cumulative cash flow.

## Discussion for economic analysis

For the production of 3000 metric tonnes of ABE from empty fruit brunches using Clostridium acetybutylicum, the fixed capital investment is estimated to be 79.605 million $ and total capital investment of 93.656million $.Meanwhile, the total annual production costs are 16.375 million $/year. Total annual production cost included raw material cost, labour costs, utilities, maintenance and etc. The cost for raw material required are estimated to be 1.86 million $/year.Usually, raw material costs are one of the major costs in a production operation. The amount of raw material required had been calculated based on the mass balances and it is 9.08 % of the total production cost. On the other hand, the labour costs are around 0.350 million $ per year. As for utilities costs, it is estimated to be 0.079 $ million per year. The cost for utilities basically included electricity, water consumption, waste treatment and disposal and etc. Since there is excess steam available which is connected from the plant nearby, there is no cost for steam in the process. The major part that account for utilities cost is waste treatment cost which is to make sure the waste dispose comply with the environmental regulations.From the cash flow diagram, the payback period is estimated to be 3.0 years with the net return of 16.52$ million per year. As for the return of investment, it is 36.7% per year.Despite of the expensive equipment purchased and installed costs, the company can gain profit within 3 years due to the inexpensive cost of raw material, and also good market of products that can sell off at high prices.