Comparison of A Tannery that using the Conventional Treatment of Waste Water and that using the Recycling Method

R. A. Salman, G. A. Gasmelseed, R. S. Hassan

Abstract—The conventional treatment methods of tannery spent float is found to be not sufficient to meet the required international standards levels of liquid discharges, on the other hand the establishment of the treatment unit for the physical, biological and chemical treatment of the spent float is found to be extremely high-cost process. During the life time of the tannery by using the recycling of the spent float method, there would be a great saving in the water and the chemicals as well as environment protection. The comparison of the capital cost estimates of two tanneries with the same capacity, one with the conventional treatment method (large treatment unit should be established) and the other used the recycling of the spent float process, show the advantages of using the recycling process over the conventional treatment process.

Index Terms—Tannery, Liquid Waste, Treatment, Recycling, Cost Effectiveness.

I. INTRODUCTION

The cost benefit analysis may be used to compare completed or potential courses of actions, or to estimate the value against the cost of a project. It is commonly used in commercial transactions, business or policy decisions and project investments.

Cost analysis has two main applications:
1. To determine the investment cost and how much its benefits outweigh its cost.
2. To compare the total expected cost of each option with its total expected benefits [1].

The capital cost estimation is an essential part of investment assessment. Many types of capital cost estimates are made, from initial estimates to detailed estimates which require the collection of accurate technical data [2].

The total capital investment for any process consists of fixed-capital investment for equipment and facilities in the plant plus working capital which must be available to pay for salaries, raw materials and products on hand, and other special items requiring a direct cash expense. Thus in the cost analysis of industrial processes, capital-investment costs, manufacturing costs, and general expenses including income taxes must be taken into consideration [3].

Types of Capital Cost Estimates

An estimate of the capital investment for a process may vary from a predesign estimate based on few information to a detailed estimate prepared from complete drawings and specifications. Between these two, there can be numerous other estimates which vary in accuracy. The following five categories normally used for design purposes:

1. Order-of-magnitude estimate, the probable accuracy of estimate over ±30 percent.
2. Study estimate, the probable accuracy of estimate up to ±30 percent.
3. Preliminary estimate, the probable accuracy of estimate within ±20 percent.
4. Definitive estimate, the probable accuracy of estimate within ±10 percent.
5. Detailed estimate, the probable accuracy of estimate within ±5 percent [3].

II. METHODOLOGY

For the two tanneries the soaking, liming unhairing processes has been carried out on paddles, three paddles were needed with a capacity of two thousand skins, also three drums are required for the deliming, tanning and retannage processes with the same capacity, as well as two fleshing and unhairing/scudding machines.

The major equipment is the same for both, only the establishment of treatment unit is necessary in the conventional method, also there is additional equipment had been required for the recycling process (filters, storage tanks, overhead tanks, pumps).

The following figures show the equipment that require for the recycling process:

![Fig. 1. The recycling process of the spent float](image)

ss: is the spent solution, rs: is the recycled solution

The capital cost estimate was done for the two tanneries with the same capacity, one with the conventional treatment method, the other used the recycling of the spent float. The capital cost estimate was done by obtaining the free on board (f.o.b) cost of the major equipment of the tannery,
then the fixed capital investment and the total production cost were estimated.

The capacity of the tannery and the equipment were specified. Then the free on board cost of the major equipment were obtained from the vendors. The total major equipment was estimated as a base of 22.9 percent of the total fixed cost. Once the fixed cost is calculated the working capital investment is estimated as well as the total capital investment.

For the recycling method there are no running, labor and maintenance cost for the treatment unit, because there will be no need for the establishing of the treatment unit. Therefore, the working capital investment is estimated to be fifteen percent of the total capital investment for the conventional method and that for the recycling method is 12.5 percent [3].

The capacity of the tannery has been assumed to be thousand wet blue pelts. The f.o.b cost had been estimated using the capacity and design data from vendors.

III. RESULTS AND DISCUSSION

A. The cost estimation of a new tannery using the conventional waste water treatment

1) The fixed capital investment

| Table I: The Major Equipment F.O.B Cost [Prices from Vendors] |
|-------------------------------------------------------------|
| Equipment: | Cost ($) |
| The paddles | 25,000 |
| The drums | 75,000 |
| The fleshing machine | 25,000 |
| The unrasing machine | 25,000 |
| The cost of the treatment plant | 100,000 |
| The total cost of the major equipment | 250,000 |

The total cost of the major equipment=$250,000.

| Table II: Determination of the Fixed Capital Investment [3] |
|---------------------------------------------------------|
| The items | Percentage on fixed capital investment (FCI) | The cost($) |
| Purchased equipment | 22.9 | 250,000 |
| Equipment installation | 8.3 | 90,611 |
| Instrumentation | 9.2 | 100,436 |
| Piping | 7.3 | 79,694 |
| Electrical | 4.6 | 50,218 |
| Engineering and supervision | 7.3 | 79,694 |
| Construction expense | 9.2 | 100,436 |
| Legal expense | 1.8 | 19,650 |
| Contractors fee | 1.8 | 19,650 |
| Contingency | 7.3 | 79,694 |
| The total fixed cost | 99.9 | 1,090,606 |

Total capital investment=fixed cost+working capital.

\[ TCI=1,090,606+WC \quad \ldots \ldots \ldots \ldots \quad (1) \]

\[ W.C=15\% TCI \quad \ldots \ldots \ldots \ldots \quad (2) \quad [3] \]

\[ 0.85TCI=1,090,606 \]

\[ TCI=1,283,065 \]

2) The total production cost

a) The direct manufacturing cost:

The items | The cost
---|---
The raw material | 0.50TPC
Operating labor | 0.15TPC
Direct supervision | 0.0275TPC
Maintenance and repairs | 0.06FCI
Laboratory charges | 0.015TPC
Utilities | 0.045TPC
Total | 0.7375TPC+0.069FCI

b) The fixed charges:

The total fixed capital charges=d.p+2%FCI (d.p is depreciation)

\[ d.p=(\text{internal cost-s.v})/\text{service life} \]

s.v is the salvage value=zero.

C. The plant overhead:

Plant over head=0.075TPC

D. The general expenses:

1. Administrative cost=0.0375TPC
2. Distribution and marketing=0.0095TPC
3. Research and development=0.003TPC

The total general expenses= 0.0375TPC+0.0095TPC+0.003TPC= 0.0473 TPC.

The total production cost (TPC)=(0.089*1,090,606)=99,977.

The breakeven point=FCI/(unit sale price)

With 5% losses the rate of production= 950W/B pelts/day

The sale=80*23,750 dozen/year

The selling price=$80/dozen

The sale=80*23,750=1,900,000

3) The gross profit

Gross profit=revenues-total cost and expenses

\[ \text{Gross profit}=1,900,000-763,651=1,136,651 \]

4) The net profit

Net profit= gross profit – tax

The tax=17%.

=1,136,651*(1-0.17)=$943,420.

5) The rate of return (IRR)

\[ IRR = \left( \frac{\text{Cumulative net cash flow at end of project}}{\text{FCI}} \right) \times 100 \% \quad [4] \]

IRR=943,420/1,283,065=73.5%.

6) The pay-back period estimation

Pay-back time (as the annual savings are constant, the pay-back time will be the reciprocal of the IRR)

The payback period= 1/IRR \quad [4].

Payback period =1/73.5%=1.36years

7) The break-even point

The break even point=FCI/(unit sale price -cost per unit)

Cost per unit for conventional method=TPC/rate of production...
The break-even point=1,090,606/(80-32.15)=22,792 units/year.

B. The cost estimation of a new tannery using the recycling method

The fixed cost of the new tannery with the recycling will be the same as that of the conventional treatment with the addition of filters, storage tanks, overhead tanks and pumps. Estimated additional equipment cost for the recycling=$40,000.

1) The fixed capital investment

The total equipment cost=150,000+40,000=$190,000

The fixed cost for the tannery with the recycling is listed in the following table.

| TABLE IV: THE FIXED COST OF A NEW TANNERY USING THE RECYCLING METHOD |
|-------------------------------------------------|
| The items                                      | Percentage of FCI | The cost |
| Purchased equipment                            | 22.9              | 190,000  |
| Equipment installation                         | 8.3               | 68,864   |
| Instrumentation                                | 9.2               | 76,331   |
| Piping                                         | 7.3               | 60,567   |
| Electrical                                     | 4.6               | 38,165   |
| Building (including services)                  | 4.6               | 38,165   |
| Yard improvement                               | 1.8               | 14,934   |
| Service facilities                             | 13.8              | 114,497  |
| Engineering and supervision                    | 7.3               | 60,567   |
| Construction expense                           | 9.2               | 76,331   |
| Legal expense                                  | 1.8               | 14,934   |
| Contractors fee                                | 1.8               | 14,934   |
| Contingency                                    | 7.3               | 60,567   |
| The total fixed cost                          | 99.9              | 828,856  |

The total fixed cost=$828,856

TCI=FCl+WC
W.C=12.5% TCI

The total production cost was calculated by the same equation that had been used
d.p=(190,000-0.00)/25=$7,600

TPC=(0.089*947,264+7,600)/0.1402=$655,538

3) The gross profit

Gross profit=1,900,000-656,145=1,244,462

4) The net profit

Net profit=1,243,854*(1-0.17)=$1,032,903

5) The rate of return

IRR=1,032,339/948,221=108%.

6) The payback period

Payback period=1/1.08= 0.92 years.

7) The break-even point

Break even point=FCI/(unit sale price -cost per unit)= Cost per unit =TPC/rate of production=656,145/23,750=27.65

Break even point=$829,694/(80-27.62)=15,839unit/year.

IV. DISCUSSION OF THE RESULTS

The working capital investment for the conventional treatment plant and that for the recycling method are different due to the fact that there are saving in chemicals and water upon using the recycling method. It must be observed that the conventional treatment method need treatment plant to construct with operating cost without any returns.

The following table shows the advantages of using the recycling method.

| TABLE V: THE RECYCLING METHOD VERSUS THE CONVENTIONAL TREATMENT METHOD |
|-------------------------------------------------|
| Items                                          | The conventional method | The recycling method |
| TCI                                           | $1,283,065              | $948,221               |
| TPC                                           | $763,651                | $655,538               |
| Gross profit                                  | $1,136,651              | $1,244,462             |
| Net profit                                    | $943,420                | $1,032,903             |
| IRR                                           | 73.5%                    | 108%                   |
| Payback period                                | 1.36 year               | 0.92 year              |
| Break even point                              | 22,792 unit/year        | 15,839 unit/year       |

The difference of the total capital investment and the total production cost of the conventional and the recycling method show the advantage of using the recycling over the conventional treatment.

The saving in the TCI=1,283,065-948,221=$334,844

The saving in the total production cost=763,651-656,145=$107,506.

V. RECOMMENDATIONS

1. The recycling of the spent float should be used to decrease the total capital investment and the total production cost as well as to increase the profit of the tannery.

2. The recycling of the spent float should be used to minimize the hazardous chemicals exists in the spent float and hence protect the environment.

ACKNOWLEDGMENT

The authors wish to thank the college of Graduate Studies and Research of Sudan University of Science and Technology for giving us this opportunity to make this research. This paper is generated from the research for the degree of Ph.D in chemical engineering at the Sudan University of Science and Technology.

REFERENCES

[1] Cost-benefit analysis - Wikipedia.htm. Available at: https://en.wikipedia.org/wiki/Cost-benefit_analysis

[2] KayodeCoker, A. (2007). Ludwig’s Applied process design for chemical and petro chemical plants.4th ed.Burlington:Gulf professional publishing.g.p.69.

[3] Peter, M.S and Timmerhaus, K.D. (1991).Plant design and economic for chemical engineers.4th ed.Singapore:Mc Graw-Hill Book Co.

[4] Sinnott, R.K. (2005). Chemical engineering design.6th ed.Chennai:Lasersword private limited.

[5] Hayes,A.(2019).gross profit.[online].investopedia. available at: https://www.investopedia.com/terms/g/grossprofit.asp [20/1/2020].

[6] Wikipedia,(2019).net income. [online] available at: https://en.wikipedia.org/wiki/Net_income. [21/1/2020].

[7] Wikipedia,(2019).break-even (economics).[online] available at: https://en.wikipedia.org/wiki/Break-even_(economics).[22/1/2020].