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Research Article

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The Economics of Multiphase Flow Meters and Test Separators in Flow Testing

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Abstract To decide between Test Separators (TS) and Multi-Phase Flow Meters (MPFM), the Capital & Operating Expenditures (CAPEX and OPEX) of each facility must be compared. An economic model is developed for evaluating the economics of Multi-Phase Flow Meters, MPFM and Test Separators, TS. A comparative study was made to consider which is more economically viable to be installed between the multiphase flow meter, MPFM and test separator, TS. The NPV was evaluated and was found to be a positive value, since Present Value (PV) for Multiphase Flow Meter, (MPFM) is - $332,618 and Present Value (PV) for Test Separator, (TS) is -$583,648. Hence, MPFM was selected, because NPV =PV_{MPFM}-PV_{TS} = (- $332,618) - (- $583,648) = $251,030.This shows that Multi-Phase Flow Meters, MPFM is a more cost-effective means of obtaining well-test data.

Keywords Test Separators, Multi-Phase Flow Meters, Multi-Phase Flow, Economic Model, Net Present Value (NPV).

Introduction

The production stream from the oil wells contains gas and water, and particulate matter in a high mixed state. The ability to control and monitor the separation process is of critical essence in the oil and gas energy industry. Multiphase flow measurement is a general term that explains multiple flow measurement in a general term. Oil and water are known to be multiphase in the energy industry. The flow is a difficult subject principally as a result of the form in which the two fluids exist inside the pipe, known as the flow regime. Until recently, large test separators that are expensive are used to separate oil, water and gas, which are measured using conventional technology. The production stream from the oil, separation and measurement approach has inaccuracies and requires operator attention and maintenance [1]. Multi-Phase Flow Meters, MFPM application has become a very promising technology nowadays. It is proven that MPFM is environment-friendly since it generates zero emission to the environment (closed loop). Despite most careful preparation of the separator metering devices, there are still limitations on the accuracy of the test separator measurements [2]. Multiphase metering delivers real-time simultaneous measurement of oil, water and gas eliminating the need for test separators. It provides instant information on reservoir production [3]. One of the problems of the multiphase measurement technology is the uncertainty of the measurement. The main source for these higher measurement uncertainties in well test data is the fact that they measure unprocessed and far more complex flows. The problem now arises as to whether the accuracy of multiphase flow meter (MPFM) compares well with that of the test separator? More so, how economically viable are the multiphase flow meters (MPFMs) when compared to test separators?

MPFM eliminates the requirement of test separators, test lines, manifold and valve system. The drawback is that it cannot be applied for offloading and well cleaning purpose [4]. Prior industry attempts to utilize the new technology of multiphase metering for production well testing in mature fields has been hampered by the high cost of multiphase meters [5].

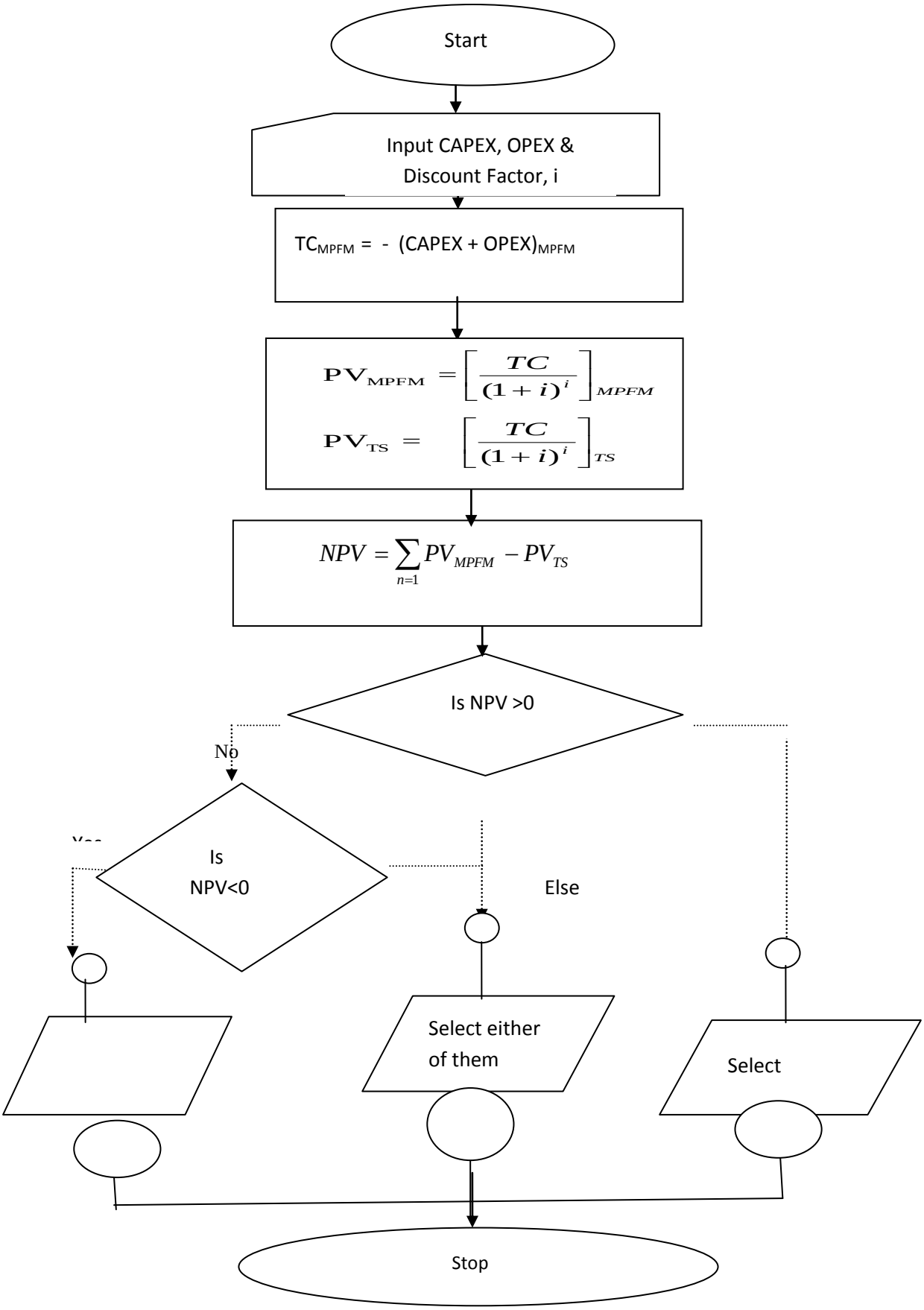

Figure 1: Flow Chart for Economic Model Development

Objectives of Study

To develop an economic model in order to compare the cost of expenditures on the multiphase flow meter and test separator for selecting best metering method for production operations that will bring about maximum benefit and return on investment.

Scope of Study

In terms of multiphase flow meters (MPFM), this work is limited to the measurement of the in-line meter of the multiphase flow of oil, gas and water. The profitability indicators will be limited to the Net Present value (NPV).

Materials and Methods

The profitability indicator such as NPV is used to select the economic service-producing investments, such as the Test Separator and Multiphase Meters.

Economic Model

The NPV is obtained by subtracting the present value of periodic cash-out flows from the present value of periodic cash inflows. The NPV can be calculated has follows:

$$NPV_{(MPFM-TS)} = \sum_{i=1}^{n} TC\left[\frac{(MPFM - TS)}{(1+i)^{n}}\right] \quad (1)$$

When the NPV is calculated, decision is made as follows:

If NPV is greater than zero, select multiphase flow meter (MPFM);

If NPV is less than zero, select Test Separator (TS);

If NPV is zero, select either of them

The following are the assumptions made in this study:

1. The equipment has a twelve-year service life;
2. There is no tax implication to the investment;
3. There is no salvage value;
4. Base case of 15% discount factor is considered.

Results and Discussion

This study gives a comparative economic evaluation of both the multiphase flow meter and the test separator. This is important, for one to decide which method to select or reject. Selecting the best equipment for production operations will bring about maximum benefit and good return on investment.

Table 1: Cost of Operation for Multiphase Flow Meter

Years	Multiphase Flow Meter	
from Start	CAPEX ($)	OPEX ($)
0	170,000	0
1	0	30,000
2	0	30,000
3	0	30,000
4	0	30,000
5	0	30,000
6	0	30,000
7	0	30,000
8	0	30,000
9	0	30,000
10	0	30,000
11	0	30,000
12	0	30,000

Table 2: Cost of Operation for Test Separator

Years from Start	Test Separator	
	CAPEX ($)	OPEX ($)
0	150,000	0
1	0	80,000
2	0	80,000
3	0	80,000
4	0	80,000
5	0	80,000
6	0	80,000
7	0	80,000
8	0	80,000
9	0	80,000
10	0	80,000
11	0	80,000
12	0	80,000

Figure 2: Model Result for Multiphase Flow Meter of 15 % Discount

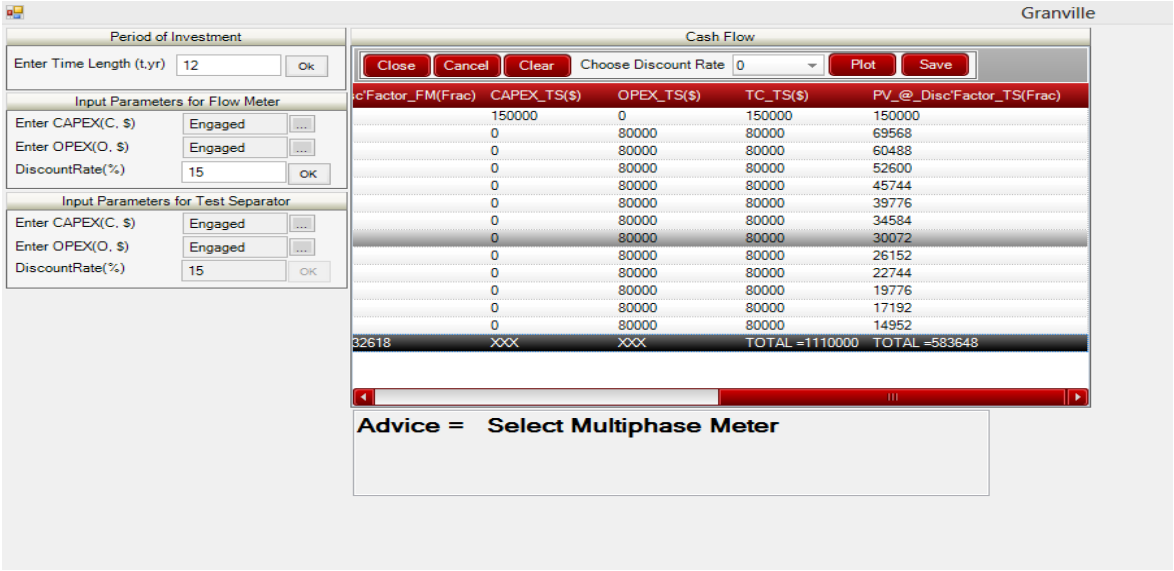

Figure 2: Model Result for Test Separators of 15 % Discount

The NPV was evaluated based on equation (1). Here, the NPV was found to be a positive value, since Present Value (PV) for Multiphase Flow Meter (MPFM) is - $332,618 and Present Value (PV) for Test Separator is - $583,648. Hence, MPFM was selected, because NPV $=PV_{MPFM}-PV_{TS}$ = (- $332,618) - (-$583,648) = $251,030. Figure 4 below shows the relationship between the CAPEX and OPEX for both MPFM and Test Separator. It is cheaper to install a Test Separator when compared to a Multi-Phase Flow Meter (MPFM), but the cost of operating a Multi-Phase Flow Meter (MPFM) over a period of time is far lesser than that of a Test Separator.

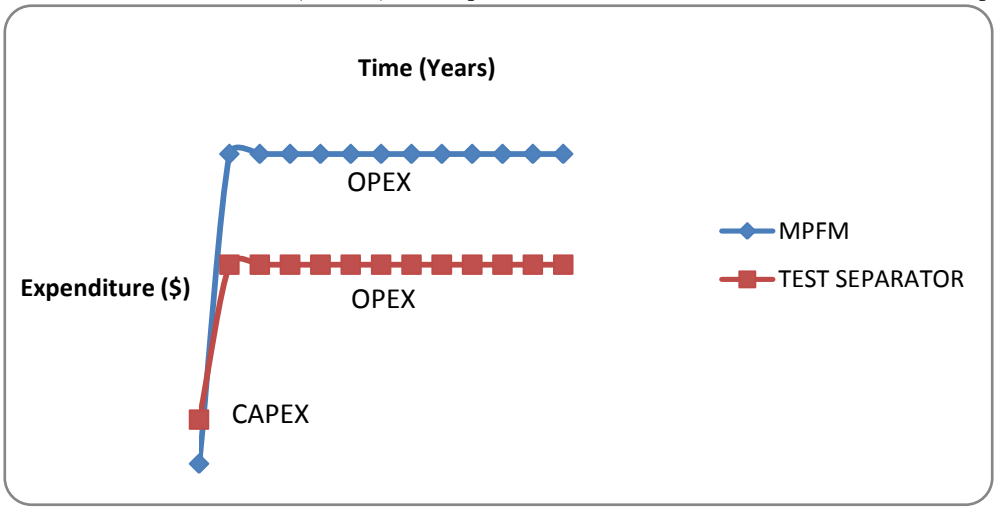

Figure 4: Expenditure curves for MPFM and Test Separator

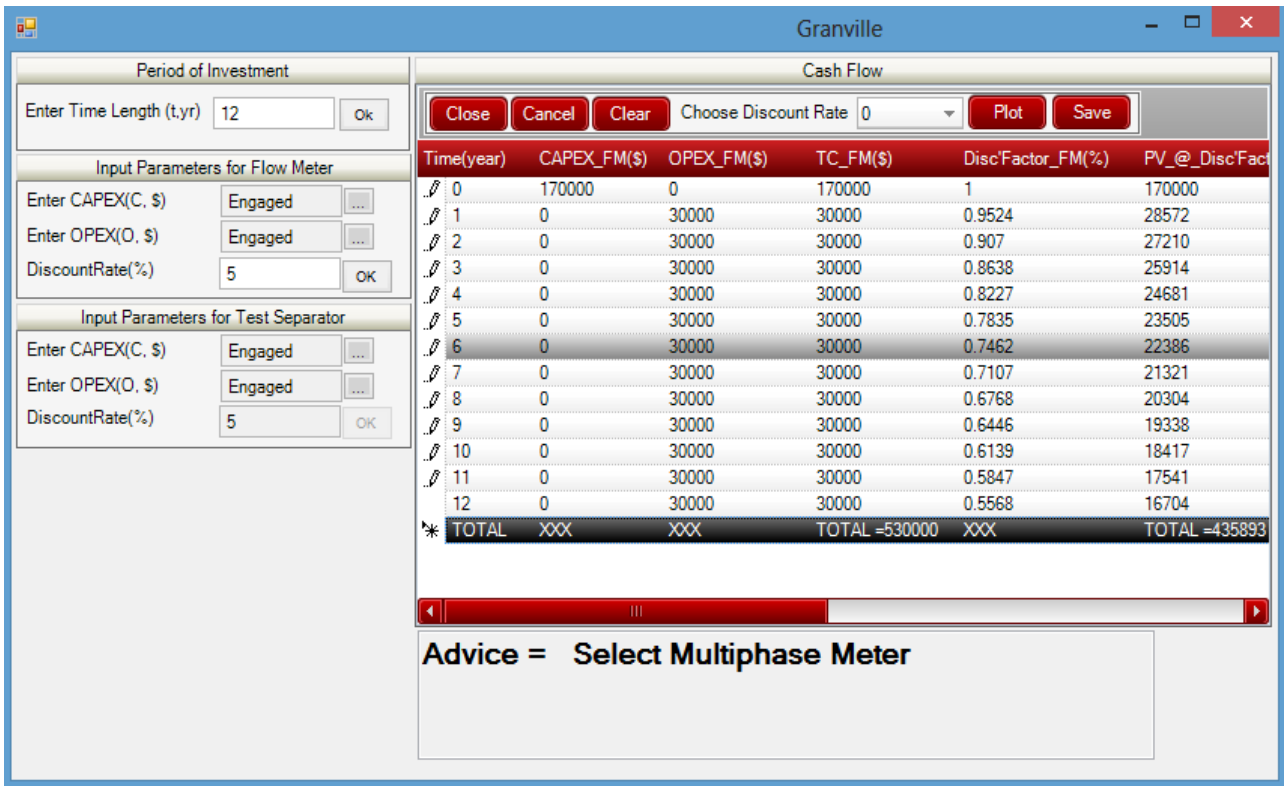

Figure 5: Model Result for Multiphase Flow Meter of 5 % Discount

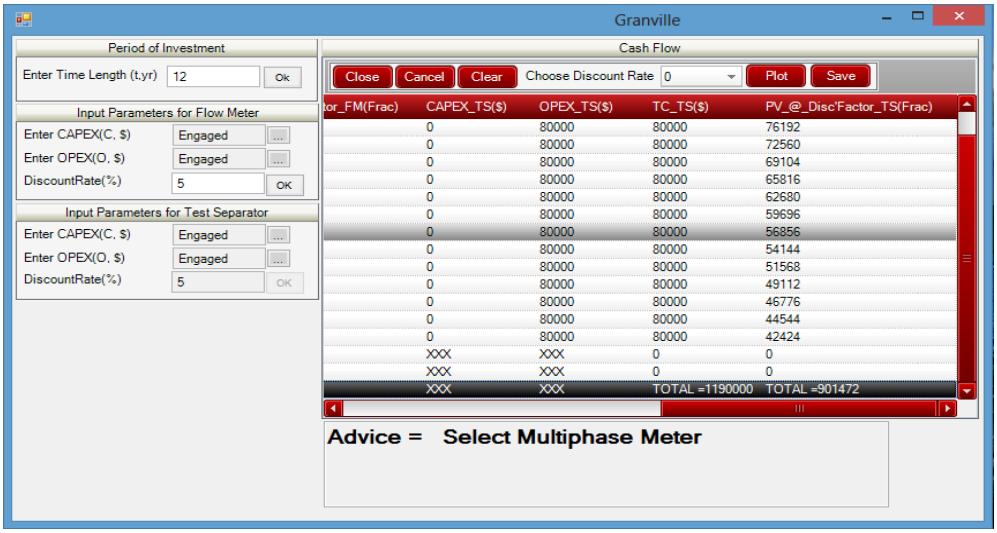

Figure 6: Model Result for Test Separator of 5 % Discount

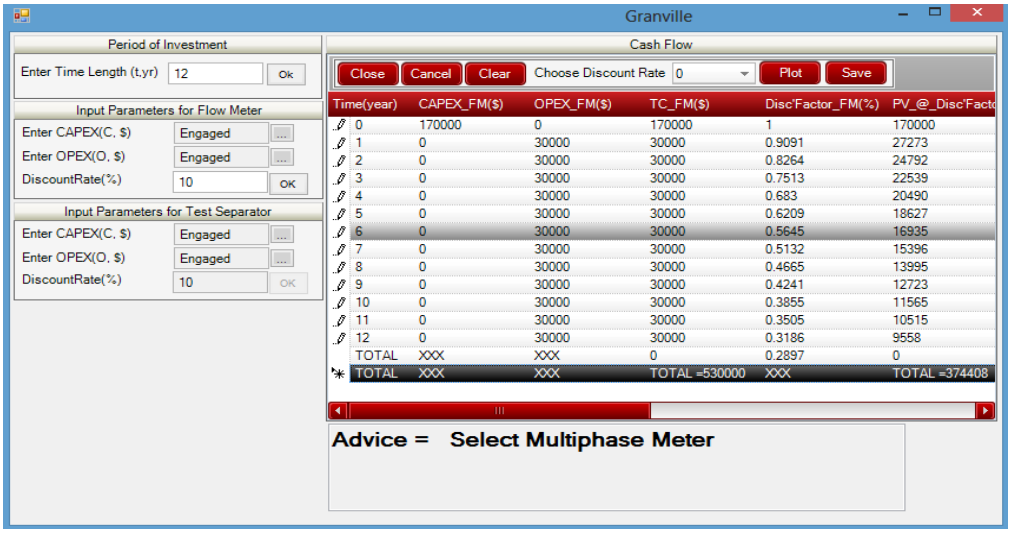

Figure 7: Model Result for Multiphase Flow Meter of 10 % Discount

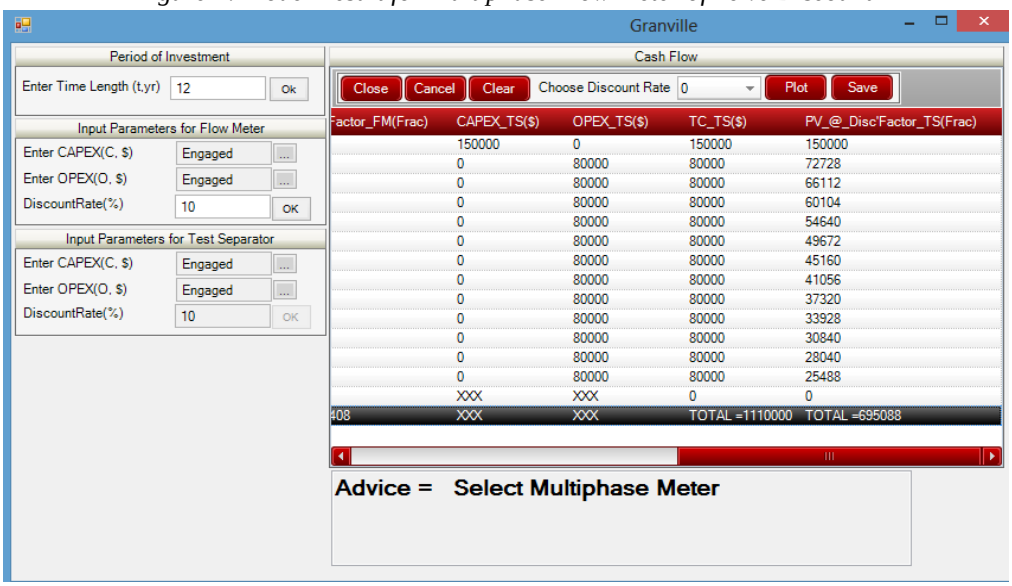

Figure 8: Model Result for Test Separator of 10 % Discount

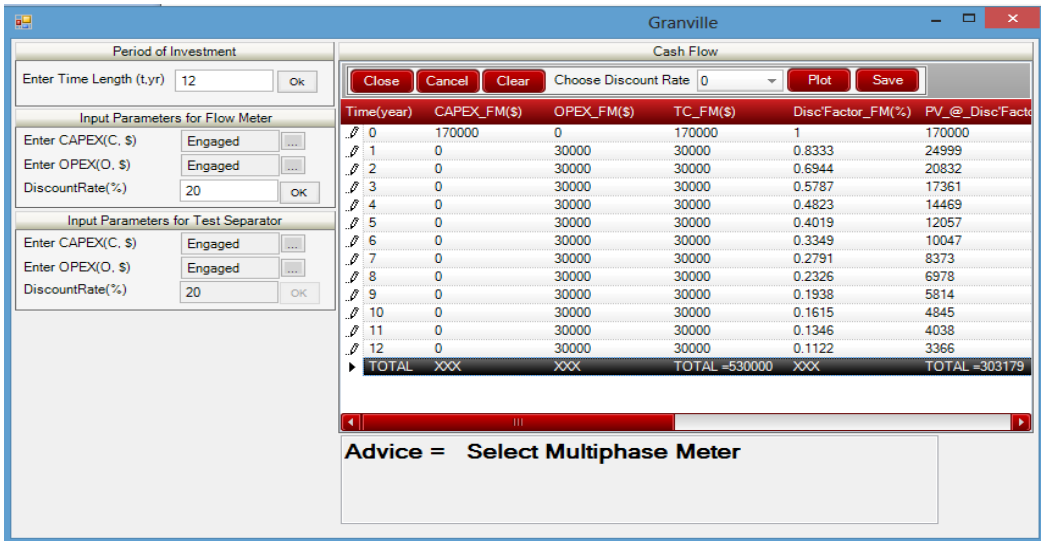

Figure 9: Model Result for Multiphase Flow Meter of 20 % Discount

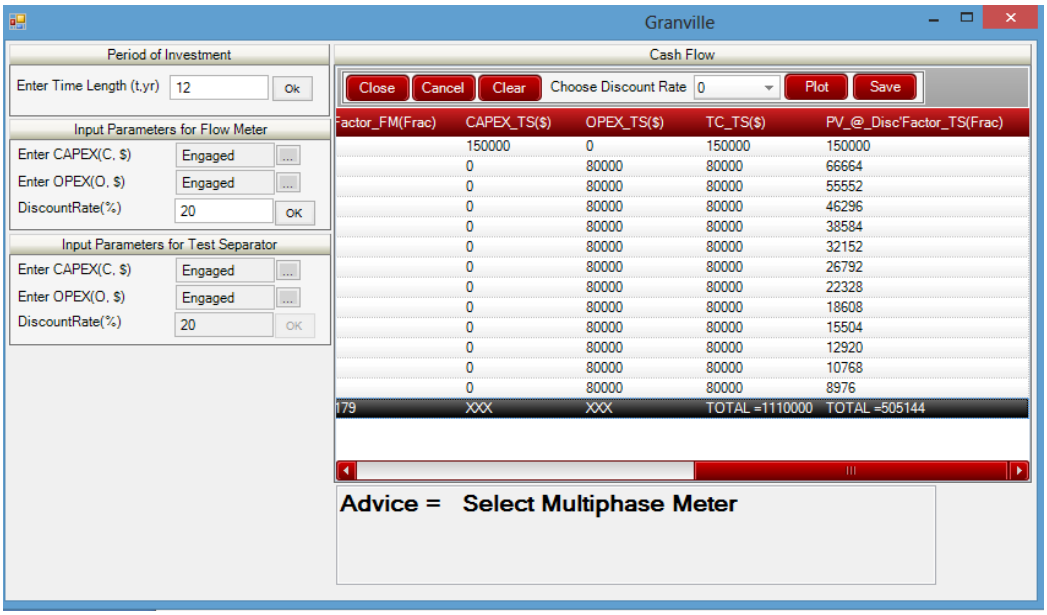

Figure 10: Model Result for Test Separator of 20 % Discount

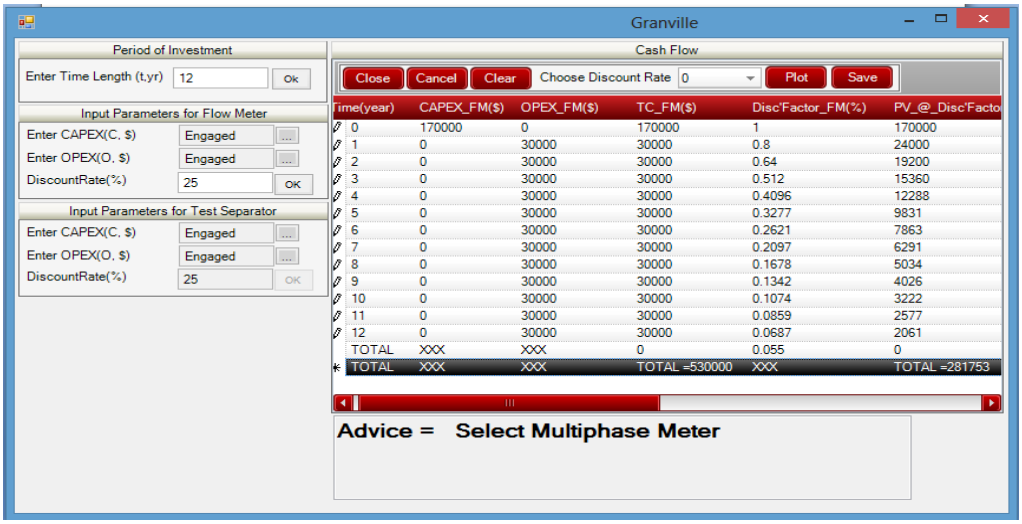

Figure 11: Model Result for Multiphase Flow Meter of 25 % Discount

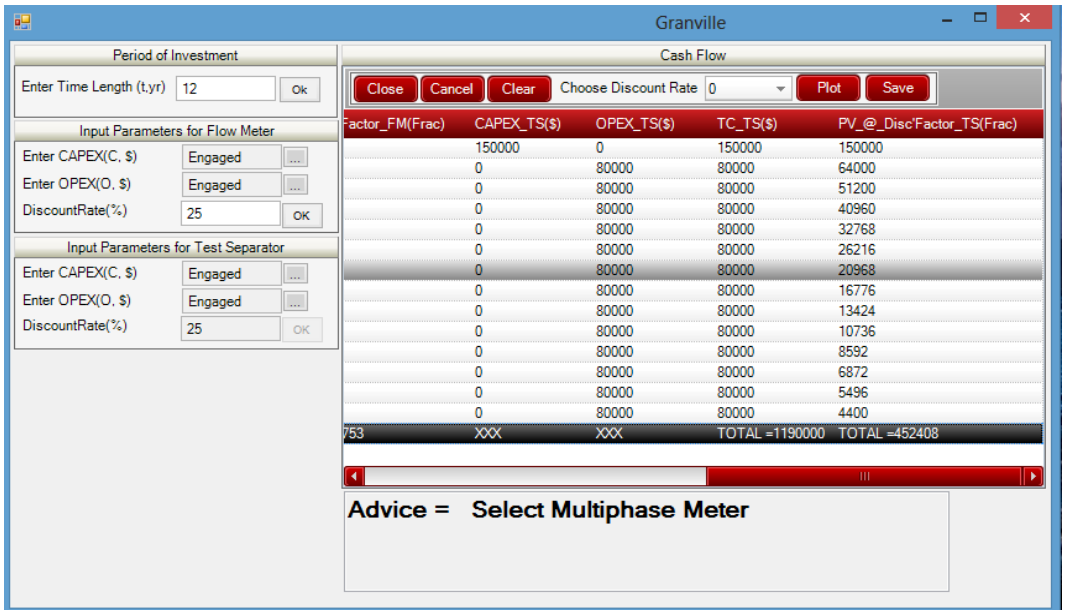

Figure 12: Model Result for Test Separator of 25 % Discount

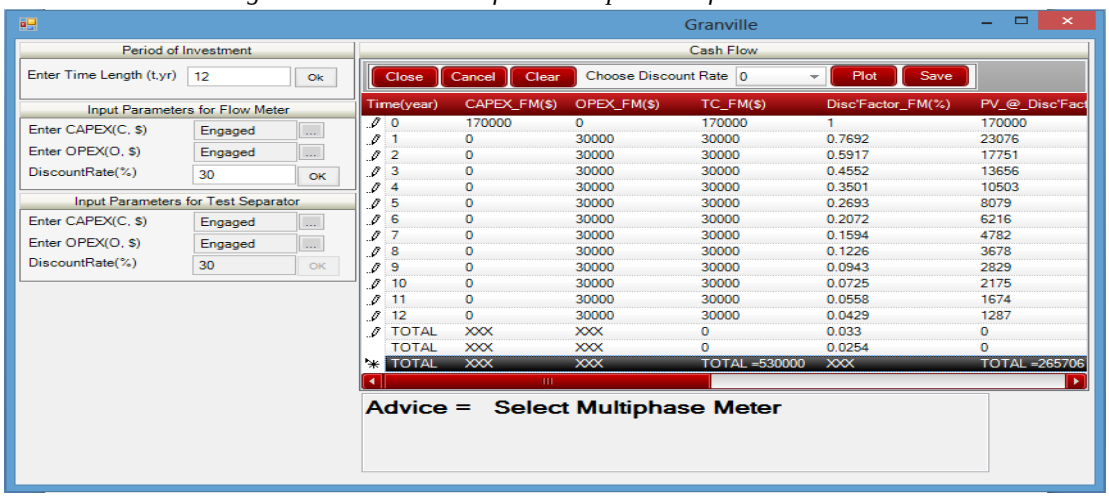

Figure 13: Model Result for Multiphase Flow Meter of 30 % Discount

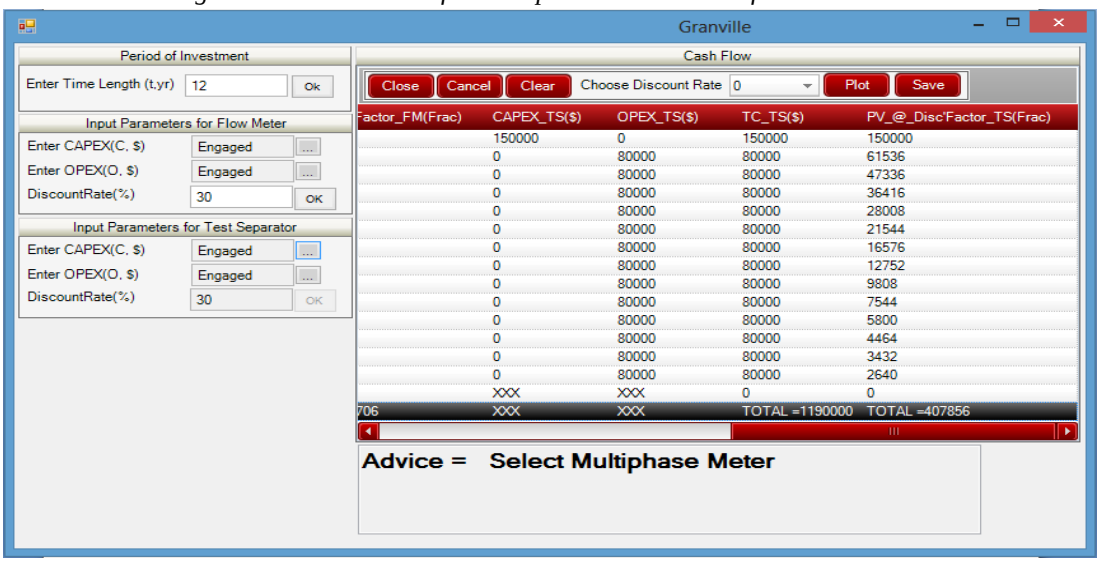

Figure 14: Model Result for Test Separator of 30 % Discount

Table 3: NPV at Various Discount Factors

Discount Factor (%)	NPV ($)	
	MPFM	Test Separator
5	435,893	901,472
10	374,408	695,088
15	332,618	583,648
20	303,179	505,144
25	281,753	452,408
30	265,706	407,856

Figure 15: Plot of NPV against Discount Factors

Figure 15 above shows the relationship between NPV and discount factors of 5% to 35%. To obtain the breakeven point, the total cost of both MPFM and Test Separator were discounted at various discount rate and the present value (NPV) obtained were used to generate Figure 15 above. From the trend, it shows that it will get to 80% to 90% for breakeven to occur. i.e when NPV for MPFM is equal to that of the Test Separator. MPFM gives a better investment proposal than the Test Separator which will give a better investment proposal if the discount factors continue to increase.

Conclusion

1. An economic model was developed for evaluating the economics of MPFM and Test Separators.
2. MPFM is more economically viable to install than the Test Separators. This means that MPFM is a more cost-effective means of obtaining well-test data.
3. Further study should be considered whether it will be more economical to replace a test separator with a multiphase flow meter when the test separator is already in place.
4. In order to enjoy the benefits of multiphase metering, companies will have to provide the financial support to the development of higher performance meters.

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References

[1]. Tuss B.M. and Kendrick R.A (1992): "Well Test System: Designing for Accuracy": paper SPE 24806 presented at the SPE 1992 Annual Conference, Washington, DC.

[2]. Dykesteen, E. and Frantzen, K.H. (1991): "Multiphase Fraction Meter Developed and Field-Tested," Oil & Gas Journal

[3]. Mofunlewi, S.S, Ajienka, J.A (2003): "Economic Evaluation of Multiphase Meters" Department of Petroleum & Gas Engineering, University of Port Harcourt, Nigeria

[4]. Wijayanti H (2005): "An Alternative for Saving Gas Burnt in Well Testing Operation by Using MPFM" SPE 93151 Asia Pacific Oil and Gas Conference Held in Jakarta.

[5]. Mehdizadeh P, Williamson J (2004): Principles of multiphase measurements, State of Alaska, Alaska Oil and Gas Conservation Commission.