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Cost-Benefit Approach to Replacing Conventional Test Separators with Multiphase Flowmeters in Today's Well Performance Monitoring

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ABSTRACT

In spite of advances in multiphase flowmeter technology since inception, test separators continue to hold relevance in well performance monitoring around the globe. This paper investigated the economic viability of replacing existing test separators with multiphase flowmeters in today's well performance monitoring using a cost-benefit approach for supporting management decision-making process. Data analysis using cost-benefit approach indicates that given the current procurement and installation cost for multiphase flowmeters, it is not economically viable to replace existing test separators with multiphase flowmeters on a per well basis. A sensitivity studyshowed companies may consider installing multiphase flowmeters on a per well basis for a facility with few producing wells but as more wells are drilled for expansion, multiphase flowmeter installation on per well basis loses its economicviability. The study supports leveragingsynergies between multiphase flowmeter and multiport flow selector value technologies as a panacea for moving the needle onconventional test separator deployment.

Key words: Cost-Benefit Analysis; Multiphase Flowmeter; Test Separator; Sensitivity Analysis; Economic Viability

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1. INTRODUCTION

The petroleum industry need for real-time multiphase flow data from individual wells was met about two decades ago with the commencement of multiphase flowmeter production by manufacturers on a commercial scale. This need was born out of a desire by field operators to eliminate the conventional means of well performance monitoring using test separators with their attendant drawbacks – They are expensive and cumbersome; they require field personnel intervention; they attract high operating and maintenance cost; and do not lend themselves to real-time continuous metering[1]. In spite of advances in multiphase flow measurement technology, test separators are still widely used in the industry for well performance monitoring. Accordingly, the attendant gains afforded by multiphase flowmeter deployment in terms of CAPEX and OPEX reduction and increased production efficiency have, for the past two decades, eluded the industry [2].

This paper presents a cost-benefit approach to analysing the economic viability of replacing the conventional test separators with multiphase flowmeters in today's well performance monitoring. It is believed that studies of this nature would provide for decision makers a decision support systemin deciding on multiphase flowmeter deployment in both existing and newly-developed oil and gas fields. Data obtained from meter manufacturers and inputs from industry experts formed the basis for the analysis.

2. COST-BENEFIT METHODOLOGICAL APPROACH

A Cost Benefit Model was used in evaluating the economic viability of replacing existing test separators with multiphase flowmeters. Cost-Benefit approach provides decision-makers with an economical assessment of project alternatives [3].The Benefit-Cost Ratio (B/C) is obtained by dividing the sum of present values of expected benefits by the sum of present values of expected cost.

The present value total benefit, $PV(TB) = \sum_{i=0}^{n} \left[\frac{FV(B)}{(1+r)^n}\right]$ (1)

Similarly, present value total cost, $PV(TC) = \sum_{i=0}^{n} \left[\frac{FV(C)}{(1+r)^n}\right]$ (2)

Thus, Benefit-Cost Ratio, B/C = $\frac{PV(TB)}{PV(TC)}$ (3)

Decision Rule:

- Accept the investment option with the greatest benefit-cost ratio (B/C)
- If B/C is equal to 1, further analysis is needed for investment decision.

Assumptions

The following assumptions were made in this study:

1. The equipment have a fifteen-year service life.
2. There is no tax implication to the investment.
3. Both equipment have no salvage value.
4. Four-yearly maintenance/service contract with 10% variation.
5. Base case of 15% discount factor is considered.

3. RESULTS AND DISCUSSION

Table -1 Costs and Benefits for Multiphase Flowmeter and Test Separators

	MPFM				Test Separator			
Year	**TC ($)**	**PV(TC)($)**	**TB($)**	**PV(TB)($)**	**TC($)**	**PV(TC)($)**	**TB($)**	**PV(TB)($)**
0	976000	976000.00	0	0	0	0	0	0
1	40000	34782.61	325120	282713.04	77120	67060.87	210880	183373.91
2	40000	30245.75	325120	245837.43	77120	58313.80	210880	159455.58
3	40000	26300.65	325120	213771.68	77120	50707.65	210880	138657.02
4	40000	22870.13	325120	185888.42	77120	44093.61	210880	120571.32
5	44000	21875.78	357632	177806.31	84832	42176.50	231968	115329.09
6	44000	19022.41	357632	154614.18	84832	36675.21	231968	100286.17
7	44000	16541.23	357632	134447.12	84832	31891.49	231968	87205.36
8	44000	14383.68	357632	116910.54	84832	27731.73	231968	75830.75
9	48400	13758.30	393395	111827.41	93315	26525.95	255165	72533.82
10	48400	11963.74	393395	97241.23	93315	23066.04	255165	63072.89
11	48400	10403.25	393395	84557.59	93315	20057.43	255165	54845.99
12	48400	9046.31	393395	73528.34	93315	17441.24	255165	47692.16
13	53240	8652.99	432735	70331.54	102647	16683.01	280681	45618.51
14	53240	7524.34	432735	61157.86	102647	14506.96	280681	39668.27
15	53240	6542.90	432735	53180.75	102647	12614.75	280681	34494.15
Total		**1229914.1**		**2063813.4**		**489546.2**		**1338634.9**
Net Present Value ($)			**833899.4**				**849088.8**	
Benefit-Cost Ratio (B/C)			**1.68**				**2.73**	
Incremental NPV ($)					**15189.4**			

The Present Value (PV) cost and benefit for both multiphase flowmeter and test separator were calculated at 15% discount rate using equations 2 and 1 respectively. The benefit-cost ratio calculation for multiphase flowmeter installation gave 1.68 while the option of continuing to use the existing test separator was 2.73. With test separator having the greatest benefit-cost ratio, this option is considered over installing MPFMs on each well to replace the test separator in well performance monitoring.

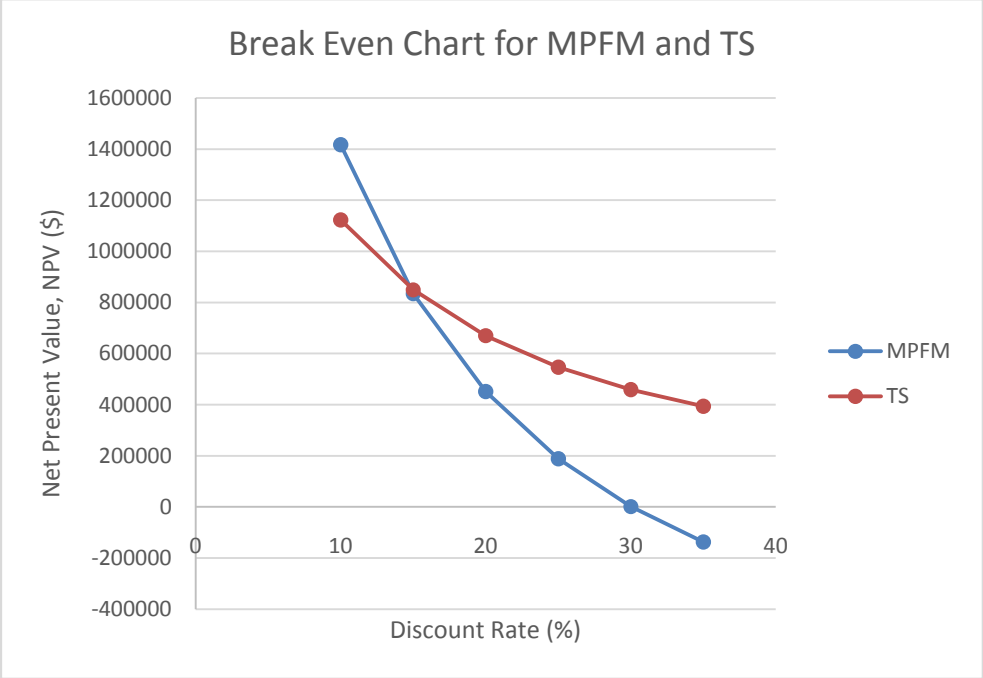

Fig. 1 Plot of Net Present Value against Discount Rate

To obtain the break even point, the net present value for both MPFM and TS were plotted at varying discount rates as shown below. From Figure 1 above, MPFM gave a better investment proposal at discount rates below the break even point while TS proved a superior investment option above the break-even point. The break-even occurred at 14.7% discount rate corresponding to $862,512.50 net benefit.

Sensitivity Analysis carried out with CBA help ascertain the impact of changes in input variables on the valuation thus enabling us to identify the most critical variables [4].

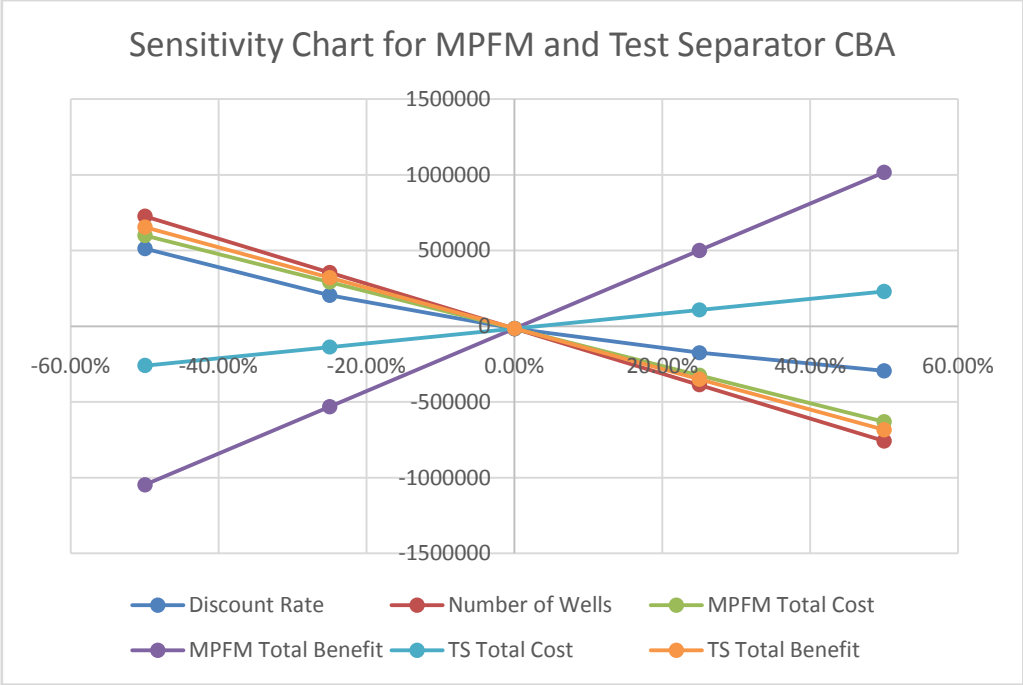

Fig. 2 Sensitivity Analysis – Spider Graph for MPFM and TS Comparison

From the sensitivity analysis chart (Figure 2), MPFM total benefit showed the highest positive sensitivity. This means that an increase in the total benefits accrued from multiphase flowmeter installation will have the greatest impact on enhancing the viability of replacing existing test separators with multiphase flowmeters. Again, the number of wells available for MPFM Installation has the least positive sensitivity. This implies that as the number of wells in an oilfield increases, the viability of installing MPFMs on each well to replace the existing test separator decreases.

4. CONCLUSION

This paper presented a decision support system based on the cost-benefit approach for choosing between conventional test separators and multiphase flowmeters in oilfield facilities.The valuation of the economic viability of replacing existing test separators with multiphase flowmeters using the cost-benefit approach indicates that given the current procurement and installation cost for multiphase flowmeters, it is not economically viable to replace existing test separators with multiphase flowmeters on a per well basis. The sensitivity analysis indicated that companies may consider installing multiphase flowmeters on a per well basis for a facility with few producing wells but as more wells are drilledfor expansion, multiphase flowmeter installation on per well basis will no longer be economical. However, the analysis supported replacing each test separator with a single multiphase flowmeter installation.

5. RECOMMENDATION

Based on the findings of this study, the need to leverage synergies between multiphase flowmeter and multiport flowselector valve technologies is recommended.A combination of these technologies would afford production managers gains in cost savings, reductions in productionfacility footprint and enhance the acceptability of multiphase flowmetering technology over test separators in well monitoring and testing.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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