Selection Of Prime Movers

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Often it is not readily apparent whether an electric motor or a gas engine is best as a prime mover for a specific application. A small saving in operating cost is greatly significant with respect to profits. For example, a reduction of 3 to 4 cents per barrel in operating costs can easily cause an increase of more than ten percent in the total profit from the project. Too often we compare a potential saving of 3 or 4 cents to the $3.00 value of a barrel of oil, and conclude that the savings are insignificant. This is not true, however. Actually, we must compare the potential savings to the "net profit" which we are getting. To determine net profit, we must deduct costs from revenue. We must deduct royalty, ad valorem and severance taxes, finding and development costs, and operating costs. Let us assume that a barrel of oil is worth $3.00. We must then deduct from the $3.00 the following costs:

- $0.375 for royalty,
- about $0.145 for ad valorem and severance taxes,
- about $1.80 for finding and development costs,
- about $0.40 for operating costs.

It may come as a surprise to some of you that, according to a Chase-Manhattan Bank study, the average finding and development cost was $1.80 per barrel. Now we see that we must think in terms of a 30 cent barrel rather than a $3.00 barrel, and we see the influence of a reduction in lifting costs of a few cents per barrel. A saving of a couple of dollars in our operating costs is equal to the profit from six to seven barrels.

A poor selection of a prime mover will result in extra operating costs over the entire project's life. Inasmuch as many projects now have a life of twenty years or more, failure to consider factors influencing operating costs will be costly. Consideration should be given to all factors which affect operating costs when choosing a prime mover. If possible, a dollar value should be assigned to each operating cost component for the expected life of the project. The "present worth method" is a means for determining such dollar values. This method recognizes the time value of money. To determine relative costs of prime movers, we must estimate the life of the project, each component of operating costs, and the life of the prime mover. We can then weigh the difference, if any, between the cost of one prime mover and another. Of course, an estimate is no better than the data with which it is made.

Let us look at a hypothetical example using the present worth method. Let us assume the following:

- A four-well lease with a future life of 20 years -
- Horsepower requirement is 10 horsepower/well,
- Electricity is available,
- Initial costs of electric motors and gas engines are about the same.
- Our experience indicates a gas engine life of four years with an average oil and repair cost of 5 cents/hour, and an electric motor life with negligible repairs is 20 years.
- Gas for fuel costs 20 cents/MCF.
- Fuel consumption of a gas engine is 15 cu. ft. per horsepower hour.
- Electricity costs 2 cents per kwh for the first 165 kwh/kw of demand and 0.8 cents per additional kwh/kw.
- Electric motor efficiency is 90 percent.

With these data we can now prepare a table (figure 1) which will show the expected cost for a 20-year period for both gas and electric motors. In this table we shall show initial costs, replacement costs, fuel and operating costs, and present worth

FIGURE I

	GAS ENGINE						ELECTRIC MOTOR			
Year	Capital Expenditure	Fuel Cost	Operating Cost	Total	PW Factor	8% PW Total Cost	Capital Expenditure	Electric Cost	Total	8% PW Total Cost
0	3200			3200	1.00	3200	3200		3200	3200
1		1050	1740	2790	.926	2584		3050	3050	2824
2		1050	1740	2790	.857	2391		3050	3050	2614
3		1050	1740	2790	.794	2215		3050	3050	2422
4		1050	1740	2790	.735	2051		3050	3050	2242
5	3200	1050	1740	5990	.680	4073		3050	3050	2074
6		1050	1740	2790	.630	1758		3050	3050	1922
7		1050	1740	2790	.584	1629		3050	3050	1781
8		1050	1740	2790	.540	1507		3050	3050	1647
9	3200	1050	1740	5990	.500	2995		3050	3050	1525
10		1050	1740	2790	.463	1292		3050	3050	1412
11		1050	1740	2790	.429	1197		3050	3050	1308
12		1050	1740	2790	.398	1110		3050	3050	1214
13	3200	1050	1740	5990	.368	2204		3050	3050	1122
14		1050	1740	2790	.341	951		3050	3050	1040
15		1050	1740	2790	.315	879		3050	3050	961
16		1050	1740	2790	.292	815		3050	3050	891
17	3200	1050	1740	5990	.270	1617		3050	3050	824
18		1050	1740	2790	.250	698		3050	3050	763
19		1050	1740	2790	.232	647		3050	3050	708
20		1050	1740	2790	.215	600		3050	3050	656
			Totals			36.413				33,150

factors for each year of future life of the project. When we determine total costs, we will find that electric motors are cheaper than gas engines.

You can see that this type of analysis requires numerous calculations and is laborious. We can, if we desire, construct a set of graphs which will indicate the proper choice of prime mover and, thus, avoid all these calculations, providing that two conditions obtain:

1. initial costs are approximately equal, and
2. repairs for electric motors are negligible.

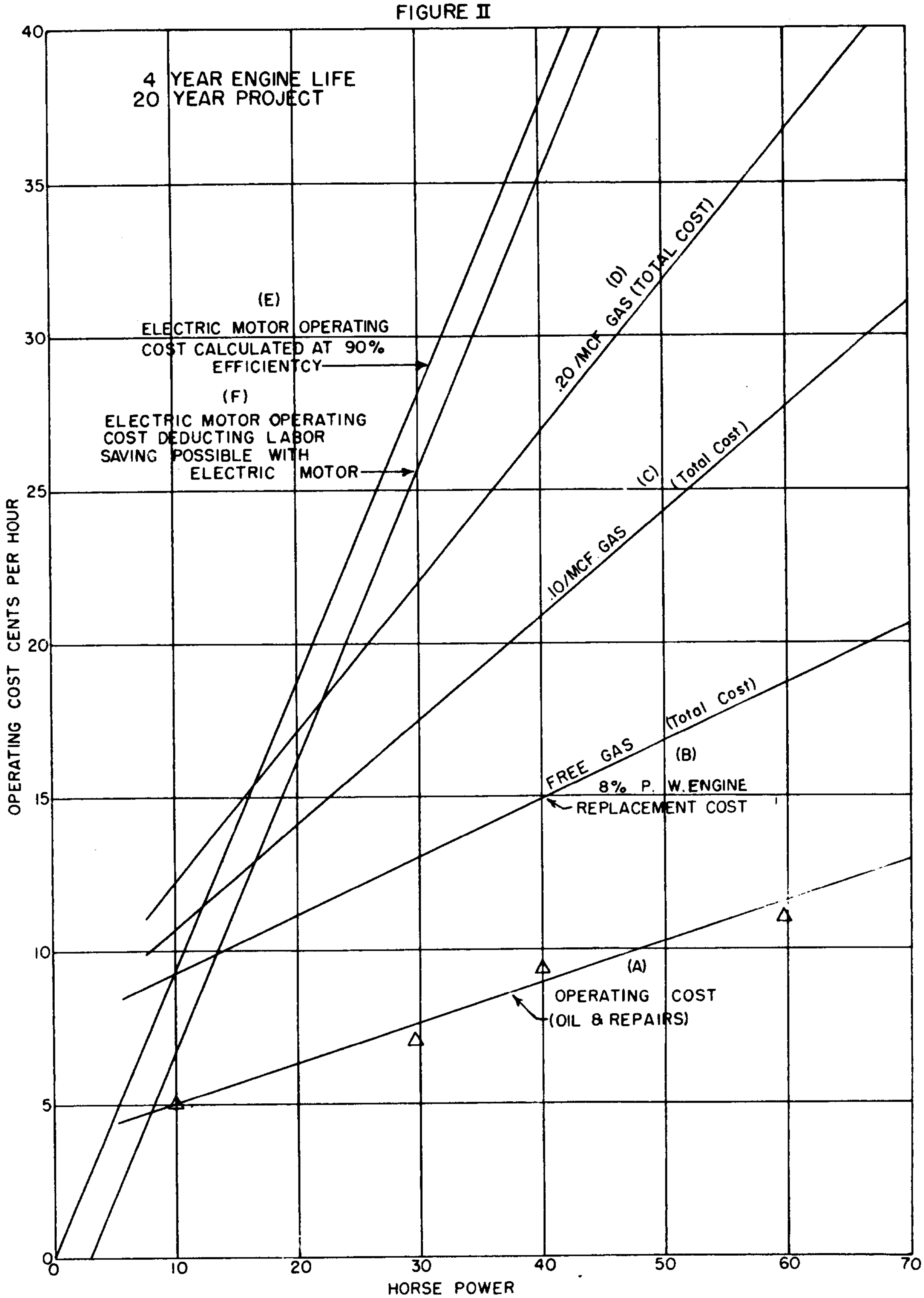
Since operating costs for both gas engines and electric motors are multiplied by the same present worth factor, we can ignore present worth and plot a graph for operating costs in cents/hour vs. horsepower for both gas engines and electric motors. We can then adjust the gas engine graph to compensate for replacement costs during the life of the project on a present worth basis. During the life of the project, four replacement engines will be needed for each well. The present worth value of these is $1,082/well. This is 4.2 cents/hour. A graph can now be drawn to reflect engine replacement costs during the life of the project. For different fuel gas values, graphs may be plotted in the same manner which does not require a consideration of present worth factors. If gas produced from the lease is used for fuel and, at the same time, some of the lease gas is flared, it should be assumed that fuel gas costs nothing. If, on the other hand, gas is used for fuel and some of the lease gas is sold, it should be assumed that the cost of the fuel gas is the same as the price for which it could be sold. With these data we can construct a graph of operating costs in cents/hour vs. horsepower. Figure II is such a graph, using the same assumptions as previously stated. This graph is for a single power unit.

If we have established operating costs through experience, a graph can be constructed which will illustrate costs vs. engine size (Figure A). In Figure B present worth replacement costs for engines of various sizes are added to the operating cost in Figure A to indicate total costs. Figures C and D show the influence of gas values. From these curves the most economical power for a particular situation is apparent. Figure E illustrates costs of electrical power. It does not show the possible savings due to automation by using electricity. Such potential savings can be shown by expressing the average reduction in costs which will result from automation in cents/hour and deducting such costs from the electric motor costs. For example, you know that with electrification you will be able to enlarge the area assigned to a pumper. He can operate more wells than he can with gas engines. We are able to recognize this saving by adding to the costs of gas engines or deducting it from the costs of electric motors. It is easier to deduct from the costs of electric motors because only one item, the cost of electricity vs. horsepower, is involved. Let us assume that a pumper can operate twenty gas engines or fourty electric motors. Based on a 160 man-hour month, a savings of 4 man-hours/month/well will result from using electric motors rather than gas engines. If the time of the pumper costs $4.00 per hour (including benefits), this reduction in pumper's time will save $16/well/month. This is a little over 2 cents/hour and can be deducted from the first electric motor cost shown on Figure F.

With electricity you can stagger your pumping schedule so that wells pump less than 24 hours per day. Although gas engines can be completely automated, we will assume for this discussion, that they must be operated continuously. Electric cost curves can be drawn that reflect savings due to 8, 10, or 12 hour operation.

The curves shown on Figure II are for assumed conditions and costs. The numbers chosen and conclusions reached were for example only. It is apparent that we need accurate data for the curves to have any value. With accurate data, this type analysis will provide a fair comparison of the cost of electric motor and gas engine operation.

FIGURE II


4 YEAR ENGINE LIFE
20 YEAR PROJECT
(E)
ELECTRIC MOTOR OPERATING
COST CALCULATED AT 90%
EFFICIENTCY
(F)
ELECTRIC MOTOR OPERATING
COST DEDUCTING LABOR
SAVING POSSIBLE WITH
ELECTRIC MOTOR
(D)
.20/MCF GAS (TOTAL COST)
(C)
(Total Cost)
.10/MCF GAS
FREE GAS
(Total Cost)
(B)
8% P. W. ENGINE
REPLACEMENT COST
(A)
OPERATING COST
(OIL & REPAIRS)
OPERATING COST CENTS PER HOUR
HORSE POWER
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70