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Artificial Lift Technology

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President OIPA
"The time and financial support our members provide are two of the association's great strengths."
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D. Michael Wallen
President KOGA
"I want to compliment Governor Patton for not taking the abandoned well plugging fund. We know he was under severe budget constraints."
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Douglas W. Reynolds Jr.
President IOPA, Tri-State
"Most of the production in the Illinois Basin is marginal and very vulnerable to lower oil price levels."
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R. Thomas Hansen
President IOGA WV
"West Virginia's leaders are cognizant of the fact that prices and production are rising. Now is not the time to interfere."
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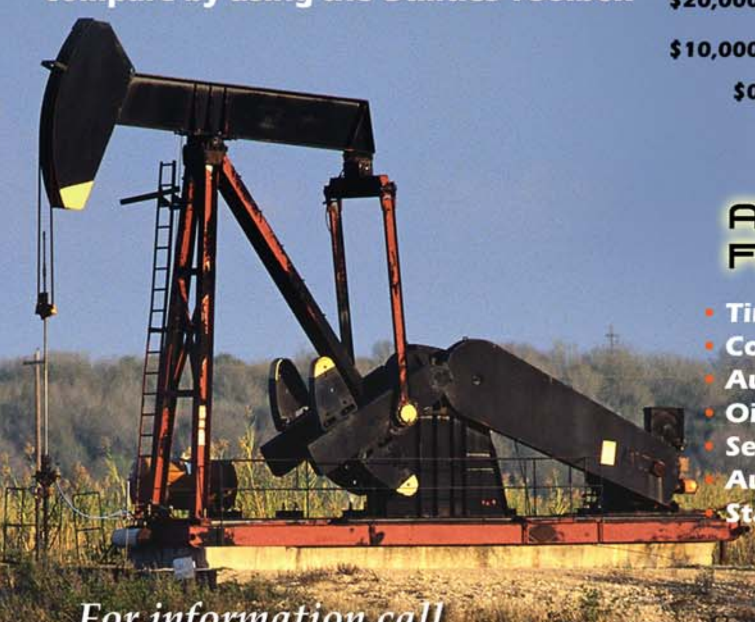
Pump Jack Power Comparison



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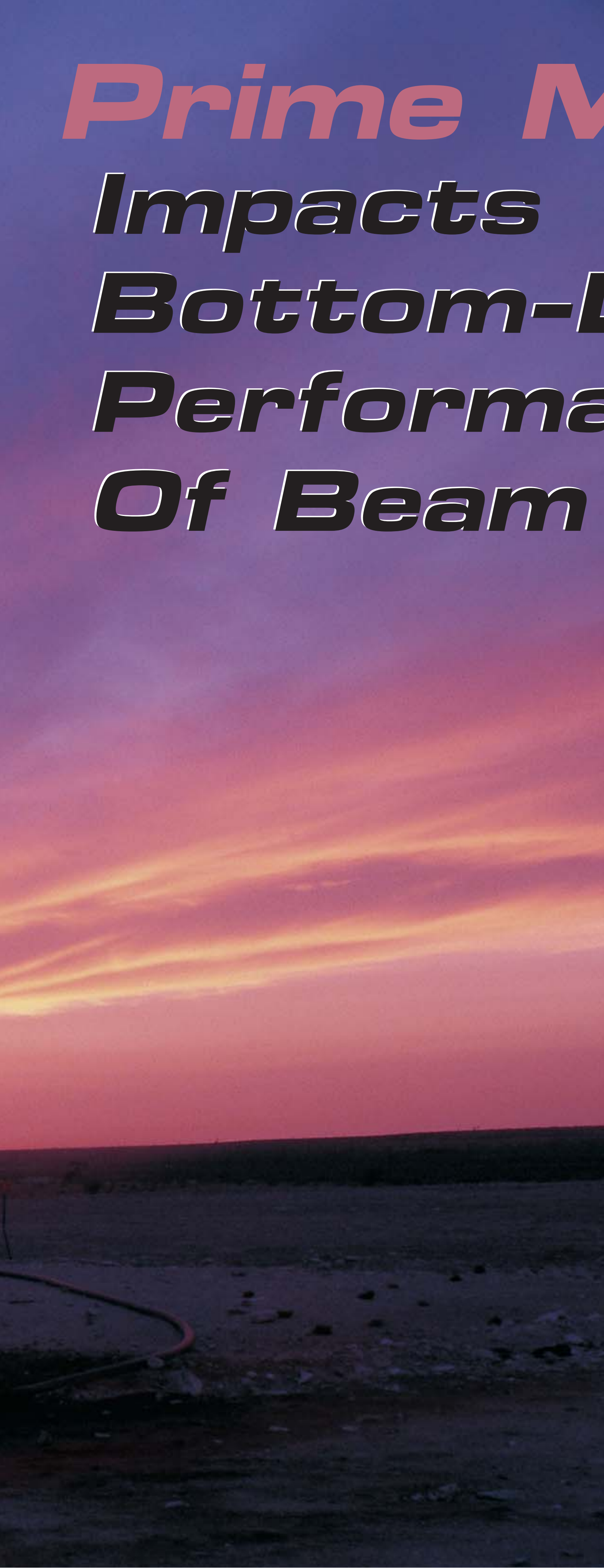


By Kavas Mistry

TULSA–Steadily rising production costs have required that every oil producer carefully evaluate and re-examine all aspects involved in lifting and pumping this commodity at the wellhead. The application of prime mover for the pumpjack is an important one, and the choice between electric motor and natural gas engine has a significant impact on the long-term economics of a particular well or oil field.

Well into the 1970s, the slow-speed gas engine was the prime mover of choice in the oil field. However, in the past thirty years, the spread of the electric utility network, combined with the need to turn wells on and off and the relatively low maintenance needs of the electric motor, has made the electric motor an attractive alternative.

The current petroleum economy advocates a reversal in this trend. Wells are pumping continuously. Electric rates have skyrocketed, and both large corporations and individual well owners are looking at long-term economics versus the benefits of short-term savings. The gas engine has since evolved into a highly versatile, dependable, and very reliable piece of equipment.

Of course, circumstances vary from lease to lease, but in many pumpjack applications, the slow-speed gas engine can be a more economical choice over the electric motor. Oil producers need to establish and analyze all the factors involved in making such a choice and use the collection of cost-related data for their final calculations in determining the economics of gas or electric engines.

For instance, consider a well site that requires 30 continuous horsepower to pump the well (Figure 1) The pumpjack presents a highly cyclical load, where the power requirement rises on the upstroke and diminishes on the down stroke. The electric motor must therefore be sized at 40 hp to carry it through the peak load duration of the cycle.

On the other hand, the gas engine has a large flywheel that stores energy and releases it as needed. A mechanical speed governor increases the fuel to the engine during these peak power requirements, hence an engine sized at 30 hp (or the average load) is adequate. Experience indicates the electric hp x 0.75 calculates the slow-speed engine horsepower.

Fuel Choices

If an electric motor is to be used, then the cost of bringing power lines to the site must be considered. This could cost as much as $20,000 a mile, and could be limited in capacity, based on local codes and utility regulations. The cost of transformers, panels and fuses/breakers also must be considered. The costs of insurance arising from this equipment must also be calculated and the risks of damage from weather and distribution problems taken into account. If electricity is already available at the site, then the costs of breakers, wiring, and hookup must be determined as well.

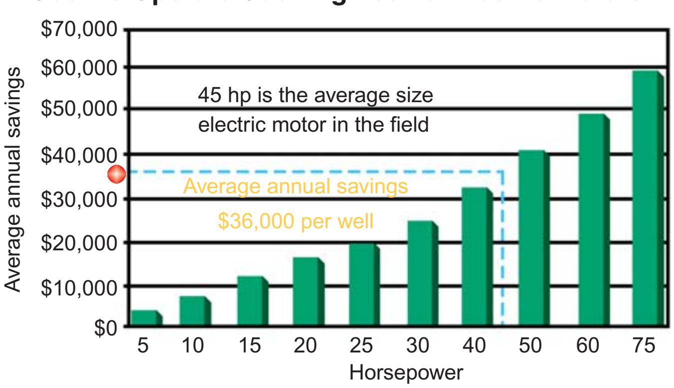
It must also be remembered that upon final depletion of the well, the power lines and infrastructure, must be left on site, unused.

In the unlikely event that natural gas is not available at the wellhead, the costs of running a gas line from the nearest source must be measured. Such costs must be obtained from a suitable local contractor. However, in most cases, casing gas is available at no cost as a byproduct directly from the wellhead. On some wells in the United States and Canada, this gas is used to run the pumpjack engine as well as an engine-driven generator to produce electricity for local use or to sell back to the utility source. This is a good way to utilize gas that the operator cannot sell commercially, but it must be handled in accordance within environmental guidelines.

The low speed and compression ratios of the gas engine allow it to use a wide range of gaseous fuels that would otherwise have no commercial value. If "saleable" gas is used to fuel the engine, its cost must be calculated based on its value at the wellhead, not at the commercial price of pipeline gas. Costs of regulators, volume tanks, and fuel line must be considered in the installation of the gas engine.

FIGURE 1

Cost To Operate Gas Engines vs. Electric Motors



Energy Costs

The annual electrical cost (AEC) to drive the electric motor, is given by the following equation: AEC = hp x 0.746 x 8760 x kwh rate, where hp is the motor horsepower requirement and kwh rate is the cost per kilowatt hour. Peak charges are sometimes levied by utility companies for electricity consumed during peak hours, but this is not taken into consideration for the purpose of this evaluation.

The natural gas consumption of the engine can be calculated using 9,400 as the specific fuel consumption of a normal engine. This means that the engine will consume 9,400 Btu for every horsepower it produces over one hour.

Therefore,

- Btu/hp/hr x hp x 24 = cubic feet/day (For purposes of this calculation, the gas is rated at 1000 btu/cubic feet LHV)
- Mcf/d x cost per Mcf x 365 = Annual fuel cost for the gas engine

Keep in mind that the value of the fuel gas can be zero if the gas is not sold or saleable.

Maintenance

Like any other equipment, maintenance is required and a vital part of ensuring ongoing well performance. Both electric motors and gas engines require routine maintenance but the costs and downtimes vary.

The electric motor often costs little to maintain. Motor condition and performance can be checked when the pumper makes regular checks on the well. A complete repair may be required every 30 months. Nonetheless, the motor is constantly subjected to sudden and unexpected power outages caused by weather or acts of vandalism or terrorism. Auxiliary pieces of equipment such as transformers and panels are also subject to failure due to the same reasons. The unpredictable nature of these problems makes it difficult to assess and evaluate the total cost to the producer. The electric motor does not lend itself to repair at site and must almost always be replaced at the first signs of failure.

The electric motor creates its emissions where gas or coal generate the power. Emissions from power plants are also a serious environmental problem.

The modern, slow-speed gas engine is very different from its predecessor of 30 years ago. Improvements in the ignition systems, starting capabilities, engine start and stop panels, safety shutdowns, and carburetion systems have made it a highly reliable prime mover and well suited to the extreme and continuous use it normally faces. The engine and its accessories can be adapted to automated systems and easily linked into telemetry and remote command controls.

Furthermore, the low BMEPs and compression ratios designed into the engine make it long lasting and dependable. Because they are designed for continuous duty, the engines offer 100 percent uptime with stoppage only for scheduled maintenance. This scheduled maintenance can be made to coincide with well and infrastructure maintenance, thus relieving the engine of any singular downtime. Various options–such as clutches, starters, low Btu fuel systems to name a few–make them a versatile prime mover, adaptable to any site condition and almost totally immune to weather. These engines are surprisingly "earth friendly," with very low emissions.

Normal gas engine maintenance includes scheduled oil and filter changes, spark plug checks and replacements, and cooling system checks. With proper maintenance, these engines have been known to operate continuously for 70,000 hours before overhaul. Years of experience with large operation and maintenance companies demonstrate that the normal engine will average a cost of no more than $1,500 a year on maintenance (including parts and labor.)

The cost comparison (Table 1) uses a 30 hp well for the purposes of calculation.

Annual Cost Worksheet

Having the ability and the necessary data to analyze the individual prime mover costs is vital. Data related to the following parameters must be collected and then used to make the choice. Various Web sites are available where the following data can be plugged in and results obtained that will help in the selection of the prime mover.

- Determine the availability of electricity versus gas. If electricity must be wired in, assess the costs of single or three-phase wiring to the site. If gas must be piped in, evaluate the costs of regulators and lines.
- Determine the size of the prime mover. The horsepower requirements of the well will depend on the depth and fluid flow of the particular well. Pumpjack manufacturers are the best judges of pump size and horsepower requirements.
- Once this power requirement is known, a suitable motor or engine size can be chosen. In the case of the electric motor, consider all switchgear appropriate to that size of motor and in the case of the gas engine, include volume tanks, regulators, and piping.
- Determine the energy cost: Establish the kwh rate for the electricity and consider all supplemental surcharges and levies. In the case of natural gas, compute the true cost paid for the fuel gas. As mentioned before, this gas could be free if it is coming off the well casing. In case it is "saleable" gas, the wellhead price of the gas must be applied. This is substantially less than the "market value."
- Determine maintenance costs. These costs tend to be site specific. Prime mover maintenance is an add-on cost to well site maintenance expenses. Again, experience tells us that it costs about $1,000 to maintain a well with an electric motor and about $1,500 for an engine-powered well.

For well sites requiring prime movers sized at 15 hp and above, the single-cylinder, slow-speed, natural gas engine is almost always considerably cheaper in a direct and fair comparison with an electric motor. The natural gas engine offers economic, reliable and convenient power, giving the operator substantial savings over many years. ❐

TABLE 1

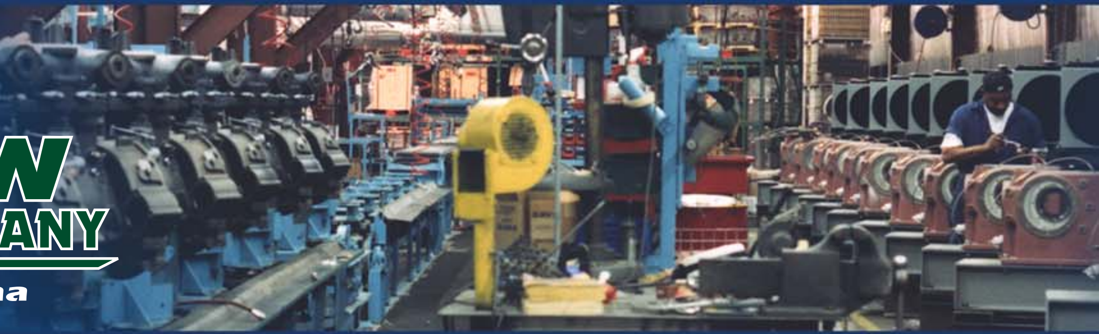
Pumpjack Cost Comparison
Electric Motor Versus Gas Engine

	ELECTRIC	GAS
Horsepower Required *(Electric hp x .75 to get Equivalent Slow Speed Engine hp)*	40	30
Unit Cost Estimated (Both at List Price)	$4,365	$18,000
Annual Cost for the Unit if Leased *(Five-year lease)*	N/A	$4,352
Hookup Cost	$350	$350
Fuel Cost Estimated	$0.13 *per KWH*	$2.50 *per MCF*
Electric Motor Efficiency Rating (Typical)	87.5%	
Annual Fuel Cost	$33,982	$6,175
Annual Maintenance Cost *(Labor and Material)*	$1,000	$1,500
Additional Feet of Electric Line Required	500	N/A
Estimated Cost per Foot	$5	N/A
Additional Cost to Run Electric Line	$2,500	N/A
Residual Value at the End of Five Years *(Estimated at 40%)*	$0.00	$7,200
First Year Cost (Cash Flow)	**($42,197)**	**($12,377)**
Five-Year Cost Comparison		
Unit Cost Over Five Years	$4,715	$21,760
Electric Line Installation	$2,500	$0.00
Maintenance Cost	$5,000	$7,850
Fuel Cost	$169,910	$30,875
Sale of the Engine at the End of Year Five	$0.00	($7,200)
Cost Over the Five-Year Period	**$182,125**	**$53,285**
Total annual savings from gas vs. electric		**$25,768**
Total five-year savings from using a gas engine vs. an electric motor		**$128,840**

KAVAS MISTRY *is corporate director–V.R. Engines at Arrow Engine Company in Tulsa where he heads up the marketing and technical activity for its multicylinder line of natural gas engines A graduate of the University of Pune India with degrees in physics, chemistry and mathematics, Kavas served for almost 30 years in various marketing and engineering positions with the Cummins organization.*

ARROW ENGINE COMPANY

Tulsa, Oklahoma



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