LINEAR ROD PUMP—A REVOLUTIONARY SUCKER-ROD ARTIFICIAL LIFT TECHNOLOGY

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ABSTRACT

For decades, the conventional beam pump has been the standard for operating sucker-rod pumping systems. Beam pumps, however, are cumbersome, mechanically complex, and difficult to control when it comes to obtaining maximum pumping efficiency or compensating for changing downhole well conditions. Unico, Inc., of Franksville, Wisconsin, has developed an artificial lift technology that is a revolutionary departure from traditional methods.

The LRP® Linear Rod Pump combines variable-speed control, simple mechanics, and sophisticated software into a compact, lightweight, unobtrusive artificial lift system that directly controls the sucker rod. Benefits of this type of system include superior speed control, optimized well performance, energy efficiency, ease of installation, portability, environmental friendliness, safety, and economy.

We will discuss the mechanical and control design of this unit. Selected field experience of the product, which has been installed on numerous wells in North America, will also be presented.

BACKGROUND

Unico, Incorporated, is a global leader in the innovation of Variable Speed Drive (VSD) products for the exploration and production of oil and gas. Founded in 1967, Unico has a history of pioneering advances in motion control, beginning with the introduction of the first high-power electronic drives for industry. For more than a decade, Unico has been developing application-specific VSD products for the petroleum market. Our unique controls background and fresh approach to the problems of the industry have enabled us to develop sophisticated control techniques that were once said to be impossible. Those advancements have been field-proven in thousands of sucker-rod pumps (SRPs), progressing cavity pumps (PCPs), and electric submersible pumps (ESPs) worldwide. The Linear Rod Pump is a natural outgrowth of our efforts to simplify and improve SRP performance.

DESIGN

Direct Drive

Traditional beam pumps require extensive mechanics to translate rotary motion into up/down motion. The Linear Rod Pump (Figure 1) takes advantage of the motor reversing and servo positioning capabilities of a flux vector variable-speed drive to directly control the sucker rod using a very simple rack-and-pinion mechanism. Direct control provides numerous benefits by eliminating the cumbersome, high-inertia mechanics of other systems. Compared to hydraulic reversing systems, the Linear Rod Pump is much more elegant and capable. Solid-state control has none of the maintenance drawbacks associated with hydraulics.

Simplicity

The Linear Rod Pump mounts directly to the wellhead using either a flange or tubing mount (Figure 2). The polished rod runs through a channel inside the rack and is suspended from the top by a conventional rod clamp. The rod is allowed to float inside the rack should the pump or rod stick. An induction motor, coupled to the rack-and-pinion mechanism through a gearbox, cycles the rack up and down to reciprocate the rod. The rack is lubricated each stroke by submersion into a fully contained oil bath. If required, a pneumatic counterbalance may be added to the system. The air balance replaces the massive counterweight of conventional systems and provides greater lifting force by storing energy during a portion of each downstroke and releasing it during the subsequent upstroke. Refer to Figure 3 for cutaway views of both units.

Capacity

Linear Rod Pumps come in a variety of models ranging from a 32” stroke with 4,000 lb. capacity to a 56” stroke with 44,000 lb. maximum capacity (see Table 1). By interchanging a small number of rack lengths, gearboxes, motors, and drives, the system can accommodate the entire range of sucker-rod pumping applications (see Figure 4).

This design provides maximum application flexibility while minimizing spare parts requirements. A companion product, the CRP™ Crank Rod Pump, is another direct-drive lift intended for shallower, low-volume wells.

BENEFITS

Ease of Installation

The Linear Rod Pump is small, lightweight, and easy to transport. No specialized or heavy equipment is required, which minimizes installation expenses. It can be carried in a light-duty truck and installed with a 1-ton rig or small picker. Installation is quick and easy and can be handled by two people. Units can be installed and fully operational within a couple of hours.

Portability

Since it is easy to transport and commission, the Linear Rod Pump can easily be moved from well to well for temporary installation or to prove reserves.

As an example, Red River Resources in Colorado recently replaced another artificial lift with a Linear Rod Pump on a well that was not producing enough barrels per day to increase gas production. Red River brought a backhoe on location, removed the existing lift, and installed the Linear Rod Pump. The new system was up and running and drawing DynaCards in less than three hours with no outside intervention or contractors required. Figure 5 shows the Linear Rod Pump next to the beam pump it replaced.

This well was free flowing for some time prior to any artificial lift being installed. With the installation of the original lift, a Unico Crank Rod Pump, the well went from 0 BPD of water and 190 mcf of gas with a liquid level of 423 feet above the pump to 40 BPD, 275 mcf, and a liquid level of 307 feet above the pump. After the changeover to the Linear Rod Pump, production increased to 82 BPD and 475 mcf with a level above the pump of 217 feet. The Linear Rod Pump was able to increase the BPD, which, in turn, increased gas production.

Environmentally Friendly

The unobtrusiveness of the Linear Rod Pump is a distinct benefit in environmentally sensitive installations. With its compact design and slender, low profile, the pumping unit blends into the landscape where conventional apparatus would be offensive or prohibited by regulation. Units can be painted to camouflage them against their backdrops, making them virtually invisible (Figure 6). There are no visibly moving parts to attract attention. Extensive site grading, mounting pads, and other disruptions to the well site are eliminated, making it easier to reclaim the land when the well is no longer needed.

Safety

The Linear Rod Pump is one of the safest artificial lift mechanisms on the market today. Unlike walking-beam mechanisms, the system has no dangerous exposed moving parts that can pinch fingers or extremities or injure wildlife. This is especially important when installations are located near residences, schools, and businesses. Protective shelters (Figure 7), which are often oversized and unsightly, are unnecessary.

Many municipalities have regulations on pumping units that were written with conventional lifts in mind. The city of Farmington, New Mexico, for example, has extensive restrictions on pumping units within city limits. Farmington requires producers to erect a “house” that encompasses and hides the entire pumping unit. Producers are also required to erect a privacy fence around the entire well site and provide landscaping, including water for planted vegetation. Dugan Production Corp., a Farmington producer, is in the process of obtaining approval for a new location within city limits. They will be proposing the Linear Rod Pump. Their desire is to get the city to allow them to reduce or eliminate the privacy fence and reduce or eliminate the building around the pumping unit. This would not only lower initial installation costs, but also reduce the cost to pull the unit since it takes additional time and money to move the building away from the wellhead when working over the well. Dugan’s Production Optimizer Marty Foutz stated, “We could pay for a LRP® unit with the money we would normally have to expend for the building around the pumping unit.”

Remote Locations

Reserves located in remote locations frequently go untapped because they are inaccessible to heavy equipment or beyond the reach of electrical service. Since the Linear Rod Pump units are so small, they can be installed virtually anywhere a pickup truck can go. Special access roads are not required. In agricultural regions, the low-profile design

allows them to fit beneath center pivots and other traveling irrigation systems to get production from farmlands without interfering with farming operations. For locations without three-phase power, a single-phase version of the system is available. When electrical service is completely unavailable or too costly to install, the system can be operated using wellhead natural gas to power a generator that supplies the drive its power.

Economical

The Linear Rod Pump reduces installation, operation, and maintenance costs. The total system may be purchased for a fraction of the cost of a comparable beam pump without controls. Installation is significantly less expensive because the unit is so easy to transport and set up. Since the unit bolts directly to the wellhead, concrete and gravel pads and other site preparations are no longer needed. Increased production increases revenue and reduced downtime expenses lowers operational costs, making the system an economical solution.

Efficient

The low-inertia design of the pumping unit allows it to use a much smaller motor and gearbox than a conventional beam pump. Beam pumps are often oversized to provide the necessary capability. Programmable motion profiles give the system the effective stroke of a much larger unit. Therefore, a much smaller unit will provide the same or better production at less cost.

CONTROL

Well Optimization

The Linear Rod Pump system incorporates patented sucker-rod pump control software that optimizes production while protecting the pumping system. Sophisticated variable-speed control achieves motion profiles that are impossible through mechanical means. Pump fill is optimally regulated by independently adjusting upstroke and downstroke speeds. This pump fill control is accomplished using a proportional-integral (PI) regulator. The PI regulator maintains a target pump fill setpoint by continually adjusting pump speed based on downhole dynamometer feedback data. Fluid impact force is greatly reduced by Soft Landing speed control, a feature that uses real-time downhole dynamometer feedback to reduce pump speed prior to fluid impact. Pumping speed is continuously adjusted in conjunction with the Soft Landing control to match well inflow. An automated valve check determines standing and traveling valve leakage. The control also provides well data reporting, embedded PLC, automatic fault restarting, and more.

Automated

A simple startup routine automatically identifies the parameters necessary for pump operation. No manual user input or adjustment is required. The system automatically adapts to changing conditions, ensuring accurate, automatic interpretation of downhole data throughout the life of the system.

Protection

Sensitive position tracking and gearbox overload protection algorithms provide automatic shutdown in the event of a stuck pump. Bridle separation control automatically slows the unit to protect against damaging bridle impact. In the event of a power outage, the unit electronically detects that power has been lost and safely parks itself through regeneration. A massive spring at the base of the unit and an optional brake provide redundant power loss safety mechanisms.

Variable Pump Stroke/Position

Pump stroke length and spacing can easily be adjusted through software. Upper and lower pump positions are set independently, allowing maximum pump compression by minimizing pump clearance volume when in the full downward position.

Superior Pump Speed Control

Downhole pump speed can be more precisely controlled due to the low inertia of the mechanism and the constant relationship between motor and rod speed. Pump speed, for example, is quickly reduced prior to fluid impact, attenuating the damaging effects of shock loads on the pump and rod during fluid pound. After fluid impact, speed is quickly increased to maximize production potential.

Low-Speed Operation
The system can operate at speeds as low as 1 spm, as compared to pump jacks without gearbox wipers, which are typically limited to 4 to 5 spm.

Sensorless Control
Rod load and position sensors are not required. The only external sensor is a single proximity reference sensor mounted directly on the pumping unit at the surface. No additional "jewelry" is required downhole or on the rod string.

Surface/Downhole Dynamometer Plots
Actual surface and downhole dynamometer plots are generated in real time. Predicted surface and downhole dynamometer plots are also generated in real time. Comparison of predicted versus actual surface dynamometer plots allows setup personnel to easily identify errors in well completion data such as rod weight, rod friction, pump size, pump depth, and the like. When predicted and actual dynamometer plots match, the rod model is precisely tuned, ensuring the downhole dynamometer plots are accurate.

Global Monitoring
When furnished with a cellular modem, wells equipped with Linear Rod Pump systems can be monitored remotely from anywhere in the world using the GMC™ Web-based monitoring and reporting system. This is an efficient way for users to stay connected to daily operations. The service provides real-time monitoring of production and performance data, historical data for analysis, automated well reports, as well as email notification of alarms and other conditions. Users can view data for all fields, a single field, or an individual well.

SELECTED FIELD EXPERIENCE
Red River Holdings, LLC
Red River Holdings (RRR) is an early adopter of the Linear Rod Pump technology and has employed it on six different wells at a ranch near Stonewall, Colorado, about 45 miles west of Trinidad, Colorado. These are coal-bed methane wells located on private land in the Raton Basin. Other CBM producers in the basin include XTO, El Paso, and Pioneer Natural Resources.

Red River Ranch is located on the larger parcel of land commonly known as the Tercio Ranch. Tercio was an old coal-mining town at the turn of the century. The property is well known for it abundant wildlife including bear, trophy elk, and high-country mule deer. The CBM development is being conducted using best management practices with a focus on minimizing short- and long-term environmental impact to the property resulting from resource development.

These wells began their production life, as many CBM wells do, using a progressing cavity pump (PCP). All of the wells had Unico VSDs installed to control the PCPs. Unico was introduced to the project by Robbins and Meyers. As with many CBM wells, once they drop below 100 BPD of fluid, another type of artificial lift is required. Prior to the introduction of the Linear Rod Pump, the only solution was noisy, eco-unfriendly hydraulic units or cumbersome conventional beam-balanced units. The ranch was not pleased with the beam units as they were not easily disguised and impacted visual aesthetics.

A typical RRR well has a two-foot sump in which the wellhead is placed. Significant time and effort was put into placing all CBM locations and access roads where they could not be seen while driving on the main ranch roads. All well pads and access roads have been reclaimed and seeded after drilling to allow natural vegetation to regrow. All electrical and production runs have been buried and the tracks seeded to disguise previous work. Buildings, artificial lift units, and junction boxes are painted a specific shade of green so that they blend into the environment.

RRR has been producing these wells for about two years. There are approximately 41 wells in production, and RRR expects to expand into another phase soon.

RRR was introduced to the Linear Rod Pump in March, 2007. They were beginning to purchase conventional beam-balanced units and were in need of an alternative lift mechanism for sites near main ranch roads. After discussions, RRR agreed to try the Linear Rod Pumps units in exchange for convenient terms since the technology was new and Unico had only installed six units at that time.

RRR appreciated the reduction in site preparation to accommodate the units. There was no need for a concrete pad, no heavy equipment was required to drag equipment to the site, no crane or workover rig was required to set the equipment, no expensive expert “company man” or crew was required to be on location to start the unit, and no special tools were required, only standard hand tools. Installation time was greatly reduced, even considering the VSD controls. In fact, RRR now installs and can pull a Linear Rod Pump with two men and a backhoe. Installation time runs about two hours.

• Well 13-4

The first Linear Rod Pump was installed on this well on May 21, 2007. The unit ran with no problems until October, 2007. It was discovered that there was a software issue that allowed the VSD to apply too much torque to the right-angle gearbox. The unit was taken to the RRR shop on the mountain and new parts shipped to location. The gearbox was replaced and back in operation within two days. Unico revised their software so that the gearbox is completely protected from failure.

A second incident occurred on this well a month later. It was discovered that the unit was operating without gear oil. It was suspected that gear oil was not replaced at the time of the earlier repair. The unit was removed from operation using a backhoe, set in the bed of a pick-up truck, and taken to the shop for review and repair. New parts were shipped overnight from Unico, the unit rebuilt on location, and it was back on the well in full operation within 24 hours.

It is interesting to note that when this well has the casing closed in for Echometer shots, the unit immediately slows down due to the restriction of fluid into the formation. Once the casing is reopened, the unit speeds up to match the inflow of the well and eventually runs at the optimum stroke rate for optimum fluid and gas production. This result has been observed on many wells with Unico’s embedded SRP VSD software.

This well has been running trouble-free since November, 2007, without any failures or workover on the well.

• Well 16-1

This was the second Linear Rod Pump at RRR. The location was chosen prior to any other type of artificial lift being set on location. Well tests indicated that this was going to be a low-flow production well of less than 60 BPD. The Linear Rod Pump was set on the well using a small backhoe on September 9, 2007, and was operational before lunch. Since this was the second Linear Rod Pump installation, RRR was able to use the same ranch hands as were used on the first well. Unico was only on location to assist with start-up of the VSD.

The only failure on this well was a VSD failure due to a single-phase condition. The VSD was replaced, and the unit was quickly back in operation.

This unit ran without any failures until we removed it for use on another well that required a higher volume than the Unico Crank Rod Pump could produce. Both units were swapped and back in operation in one day.

• Well 13-1

RRR installed this third Linear Rod Pump on November 11, 2007. The unit went on the well with relatively no problems other than the standoff plate did not match the drilling and workover flange of the well. A welder was called in to elongate the mounting holes for installation.

This well experienced a gearbox failure in December, 2007. For future protection, Unico changed the default motor rated torque from 100% to 75% on the constant torque rated drives. There have been no failures since.

• Well 12-2

Well 12-2 is the deepest well on which the Linear Rod Pump has been installed to date (2,348 feet). This unit also has the largest gearbox and motor combination yet used. The system was installed in November, 2007. Some issues were experienced after a couple of weeks of operation. More dynamic braking capability was required as the rod string loaded up. A larger capacity DB unit remedied the issue. A stuck pump downhole was also experienced. The well was pulled, and it was discovered that we had a downhole pump failure.

Due to location of this well and the BPD requirement, RRR decided to go back to a PCP ump until water levels can be reduced. The unit will either be re-installed on the well in the spring or utilized on another well.

• Well 2-3

This well went without a hitch from start to-finish and was installed on November 13, 2007. It was set and programmed in about one hour. The well has been running since without any failures or workover on the well. Figures 8 through 10 show a Unico Well Report from this well. This well report is generated from the drive. These reports have proven to be very easy to create and useful for reporting on the condition of the wells and/or troubleshooting purposes.

• Well 11-2

This well originally had a Unico Crank Rod Pump installed. Although that unit was running well at this location, RRR required more water production than could be achieved with that type of artificial lift.

The Linear Rod Pump was installed on January 11, 2007. The unit has increased water production from 40 BPD to 82 BPD and increased gas production from 275 to 475 mcf/day.

It is Red River's opinion that the Linear Rod Pump is a very effective and well-engineered mechanical artificial lift device. The unit is a good alternative rod pump artificial lift, especially for environmentally sensitive areas. Maintenance is comparable to a beam unit and the pump-off control aspect of the VSDs is a real benefit to controlling water level in shallow CBM wells.

The installations at RRR are summarized in Chart 2. This is a graph of RRR production from beginning of production/sales to January 01, 2008.

Coal-Bed Methane Wells in Appalachia

Linear Rod Pump technology is solving problems on coal-bed methane wells in Appalachia. Some of the advantages of the system in that application are discussed below.

• Water Line Freeze-Ups

The Linear Rod Pump has several unique advantages for avoiding frozen water lines. Unlike traditional pump jacks, which typically operate on local on/off timers, the Linear Rod Pump has an extremely wide range of operating speeds that allow it to produce fluid at very low or high flow rates continuously. As CBM wells mature, the amount of water they make falls dramatically. The Linear Rod Pump can reduce its speed down to 1 spm to keep water flowing 24/7, keeping water lines from freezing, which frequently occurs during a pump jack's normal off time. While the pump jack off time may be reduced to avoid freezing in very cold conditions, this only further aggravates fluid pound and produces gas up the tubing. It also diminishes the well tender's time and productivity.

Adding a simple pressure transducer to the water line provides pressure feedback directly to the Linear Rod Pump control, which can shut down the pump in the rare event of a frozen line to prevent further damage throughout the entire rod pumping system due to overpressure. This is an inexpensive way to avoid workover rigs, expensive repairs, and costly downtime.

• Compressors Going Offline

Pump jacks that operate with timers can present problems when gathering line compressors go offline. The pump jacks will continue to run whether or not the compressor is operating. When compressors go down, whether scheduled or not, pressure in the gathering lines naturally increases until local relief valves lift to vent off the excess well gas into the atmosphere. Running the pump jack only compounds the problem by producing more gas that must be vented as well.

The Linear Rod Pump will also continue to operate when the compressor goes offline but it is naturally self-limiting. The system will only operate as long as there is adequate pump fill. As the casing pressure increases, it pushes the fluid level down to the point where the pump will temporarily go to sleep. When the system wakes up, it will only operate if it can maintain the minimum pump fill required to keep the system running.

Further common problems with pump jacks in this scenario include pounding fluid and pumping gas up the tubing,

which is also needlessly vented to the atmosphere. Tubing gas can be greatly reduced if not completed avoided by applying the Linear Rod Pump technology. Fluid pounding is also eliminated, which greatly increases the useful life of the rod pump.

• Automatically Compensates for Reduced Fluid Production

As CBM wells mature, their water production declines. A typical well may go from several hundred barrels per day down to less than fifty. The Linear Rod Pump automatically compensates for these changes. There are no periodic adjustments to make or sheaves to change to adjust the strokes per minute. The system adjusts its stroke rate automatically on each stroke to maintain a minimum pump fill. For the life of the well, operators do not have to worry about changing on/off timer settings or re-sheaving the motor for different pumping rates. The system not only draws surface and downhole dynamometer plots on each and every stroke, but it also interprets those and adjusts its speed accordingly. The system is always trying to maximize water production using this technique to keep the fluid level down at the pump and to minimize any gas produced up the tubing at the same time. It does this without any operator intervention.

Prolonged power outages can affect how a well on a timer recovers once power is restored. Figure 12 shows how a well with a Linear Rod Pump came back on line and pumped the well back down without any operator intervention. The pump ramped up to 8 spm and gradually dropped to 3.75 spm, maintaining an average pump fillage of about 85%. Should the pump fail to make 65% pump fill on several consecutive strokes while at minimum speed, the system will go to sleep for a short period of time.

• Ideal Fluid Level

CBM wells can have continuously and widely varying inflow rates. The Linear Rod Pump responds to these conditions to maintain the proper fluid level. Without any sensors, it monitors downhole conditions and automatically adjusts its stroke rate to keep the fluid level pulled down to the pump without overpumping and producing gas up the tubing. A readout of the fluid level over the pump is continuously updated on the production screen.

• Accurate Water Production Without External Flow Meters

Linear Rod Pumps measure the fluid produced on each lift to provide the operator with accurate fluid production information. The turbine flow meters that are used in conventional systems are often inaccurate when measuring intermittent fluid flow, especially at low flow rates. These meters are designed to operate with continuous flow in a given pipe diameter that is full of fluid. Normally, the fluid produced does not completely fill the piping, so water can simply pass by the internal turbine, resulting in a poor indication of actual production. The Linear Rod Pump measures water accurately on each stroke, saving the expense of the turbine flow meter

• Production/Gauge Data

Accurate gauge and current production measurements are available anytime.

Dugan Production Corp.

Dugan Production Corporation, of Farmington, New Mexico, installed a Linear Rod Pump in October, 2007, as a test of the new technology. They were looking to replace existing units on coal-bed methane wells at various locations that were experiencing decreased water production through years of dewatering.

Upon installation, the unit started off well and was up to its maximum stroke rate. It then started to fine-tune itself, and the stroke rate began to drop. Dugan saw a small increase in production, then it leveled back to normal. The artificial lift mechanism that the Linear Rod Pump replaced was a standard beam-balanced unit. There was a slight increase in production due to the unit determining that it could run at maximum SPM (operator set at 15 SPM) until the speed was too fast for the inflow characteristic of the well. The Unico VSD determined that a lower SPM would better suit the characteristics of the well, so a lower SPM was chosen automatically.

Interestingly, this well uses the GMC™ remote monitoring system that continuously monitors well performance and makes the data accessible to any Internet-enabled device. Using this system, Dugan has witnessed many times where the Linear Rod Pump will slow down to the user-determined minimum 2 SPM when the line compressor goes down. Since the pressure increases in the casing, pushing fluid back into the formation, the system slows down to match the inflow of the well. When the compressor comes back on line, the units starts at 7 SPM and gradually increases

until it reaches its maximum stroke rate, where it operates until the fluid rate drops off again. In effect, the system is working harder to make up the production lost while it was down.

Safety and aesthetics are important at the well sites operated by Dugan. According to Marty Foutz, Production Optimizer, “The main thing I like about the LRP® system is its safety. There are no moving parts to get caught in. It makes sense to use it around houses where kids may be present. I also like its small footprint. It leaves a lot more room on location to do other things. It also blends into the landscape because there are no moving parts to catch your eye. It hides very well.”

BIBLIOGRAPHY

LRP® Linear Rod Pump: A Revolutionary Sucker-Rod Artificial Lift System. Brochure. Unico, Incorporated, Franksville, WI, 2007.

Red River Ranch LRP® Well Report, January 22, 2008. Unico, Incorporated, Franksville, WI.

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Senesac, Dan, Sales Engineer, Unico, Incorporated

Table I
Model Specifications

Model Number	Rod Stroke *(in)*	Rod Force *(lb)*	Rod Speed *(fpm)*	Pump Speed *(spm)*
L-073g-mmmm-032	32	4,000	5-200	0.5-20.0
L-137g-mmmm-032	32	7,000	5-200	0.5-20.0
L-239g-mmmm-032	32	12,000	5-200	0.5-20.0
L-381g-mmmm-044	44	20,000	7-275	0.5-20.0
L-381g-mmmm-056	56	20,000	9-350	0.5-20.0
A-239g-mmmm-044	44	26,000	7-275	0.5-20.0
A-381g-mmmm-056	56	44,000	9-350	0.5-20.0

Table 2
Red River Ranch Installations

Well Number	Well Depth (feet)	Pump Stroke (inches)	Plunger Size (inches)	Pump Maximum SPM	Pump Maximum BPD	Pump Test Date	Pump Test SPM	Pump Test BPD	Days of Operation	Total Pump Cycles (2/8/08)
LRP Wells										
2-3	1,417	32.0	2.00	20.00	242	01/22/08	11.54	140	117	1,944,259
11-2	878	32.0	1.50	20.00	136	02/04/08	13.51	92	23	447,451
12-2	2,328	32.0	2.25	20.00	307	10/26/07	8.72	134		
13-1	979	32.0	2.00	20.00	242	12/19/07	6.47	78	62	577,642
13-4	1,160	32.0	1.50	20.00	136	12/10/07	9.87	67	227	3,226,306
16-1	1,141	32.0	1.50	20.00	136	09/27/07	4.48	31	115	741,888
CRP Wells										
11-2	878	12.0	1.50	24.00	63	10/11/07	20.00	52	31	892,800
16-1	1,141	12.0	2.00	24.00	112	02/04/08	10.00	47	8	115,200

Casing Diameter (inches)	5.500
Tubing Diameter (inches)	2.875
Rod String Diameter (inches)	0.750

Figure 1— LRP® Linear Rod Pump

Figure 2—Tubing and Well Casing Mounting Options

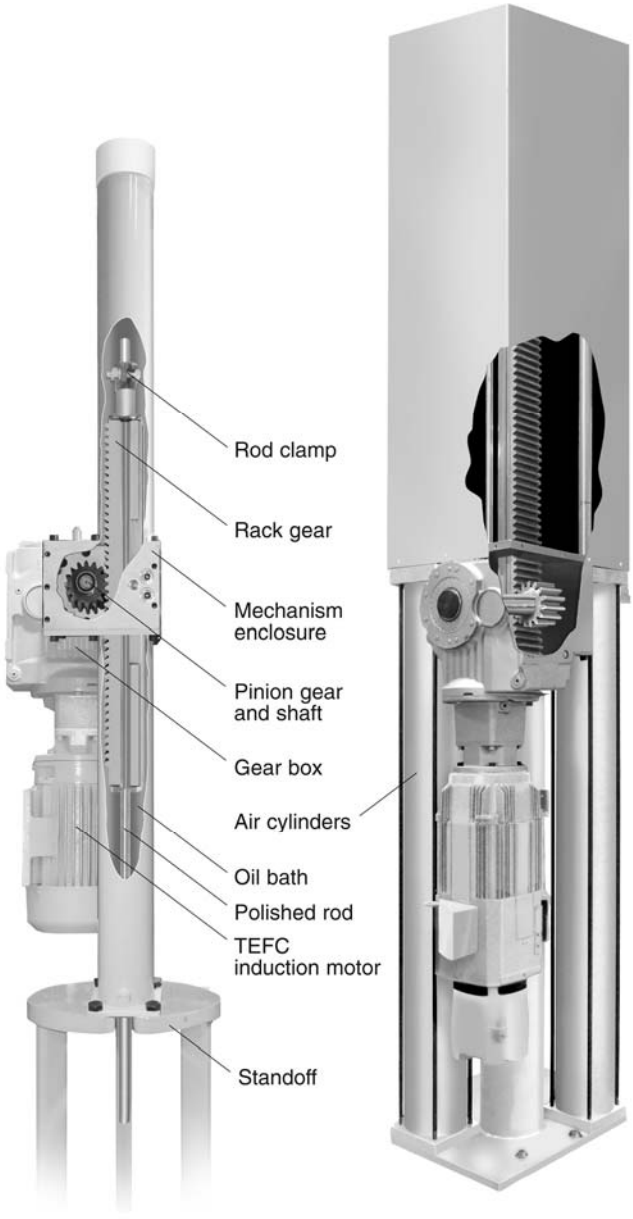


Figure 3—Standard (left) and Air-Balanced (right) Units

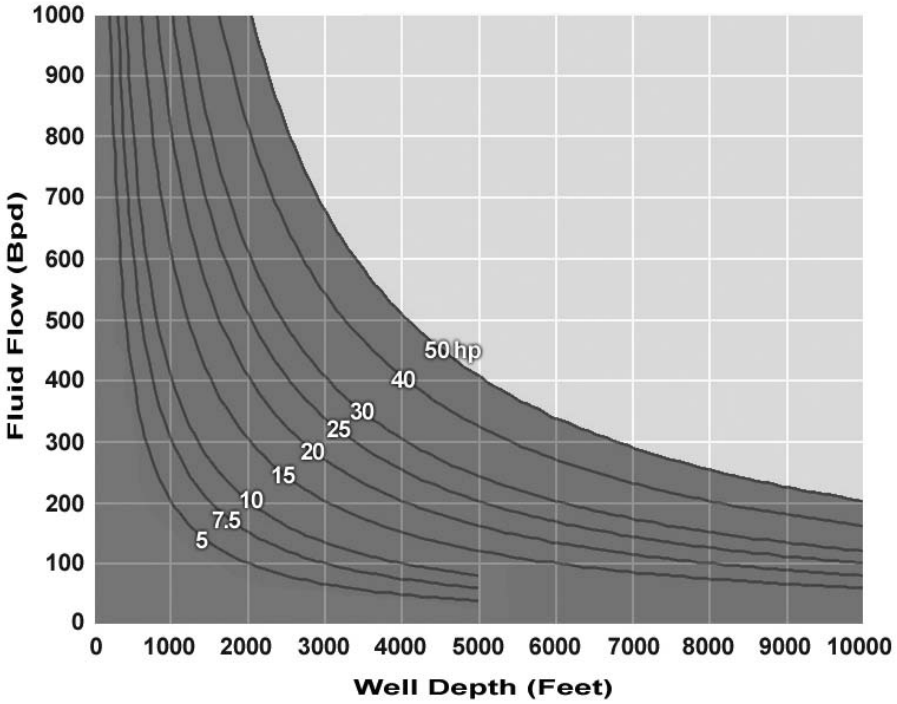


Figure 4—Fluid Flow vs. Pump Depth for Various Drive Sizes

Figure 5—Linear Rod Pump Retrofit of Beam Pump

Figure 6—A Unit Camouflaged to Blend into the Landscape

Figure 7—A Conventional Beam Unit Camouflaged to Blend into the Landscape

LRP Well Report

Pump Optimization System

Date	1/22/2008
Time	3:27:23 PM

Customer	Red River Ranch
Field Zone	Red River Ranch
Well Identification	2_3 0
Pump Description	UNICO -- LRP -- 10-80-32

805661.201

Pumping Unit Specifications

Unit Rated Torque	10,000 in-lb
Unit Rated Rod Load	8,000 lb
Unit Rated Rod Stroke	32.0 in
S Rod Stroke	24.2 in
Motor RMS Limit	13.09 Arms

Loading Statistics

Peak Up Torque	10,235 in-lb
Peak Down Torque	10,010 in-lb
PPRL (Peak Polished Rod Load)	4,507 lb
MPRL (Min. Polished Rod Load)	1,613 lb
PDPL (Peak Downhole Pump Load)	2,082 lb
MDPL (Min. Downhole Pump Load)	-107 lb
Rod Stroke	27.1 in
Pump Stroke	20.5 in
Motor Thermal RMS	8.89 Arms

Rod and Pump Data

Pump Depth	1,417 ft
Rod Weight in Air	2,354 lb
Rod Weight Buoyant	2,064 lb
Pump Load Monitor	1,935 lb
Pump Load + Rod Weight	3,999 lb
Plunger Diameter	2.000 in

Well and Fluid Data

Fluid Level Monitor	1,369 ft
Fluid Over Pump Monitor	48 ft
Tubing Pressure	9 psi
Casing Pressure	15 psi
Pump Intake Pressure	37 psi
Pump Discharge Pressure	649 psi

Operating Conditions

Running Status	AUTO RUN
Speed Source Select	OPTIMIZE
Pump Speed Source	OPTIMIZE

Operating Statistics

Request SPM Up	11.8 spm
Request SPM Down	8.3 spm
Pump Average SPM	10.27 spm

Fluid Production Data

Fluid Fill Monitor	86 %
Pump Rate Monitor	83 bpd
Plunger Leakage	3 bpd
Tubing Stretch Loss	2 bpd

Gauged Statistics

Gauge Run Time	0.00 hh.mm
Gauge Fluid Production	0 barrels
Gauge Avg Spm	0.00 spm
Gauge Avg Fill	0 %
Gauge Strokes	0 strokes
Gauge Power Meter	0 kWh/Day
Gauge Energy Consumption	0 kWh/Barrel
Gauge Fluid Flow	0 bpd

Power Statistics

Input Average Power Monitor	3.23 hp
Motor Average Power Monitor	1.56 hp
Motor Peak Power Monitor	8.68 hp
Rod Average Power Monitor	1.03 hp
Lift Average Power Monitor	0.86 hp
Lift Efficiency	26.6 %

Belt and Balance

Balance Monitor	-3,210 lb
Gear Ratio	25.62 : 1

Fluid and Gas Statistics

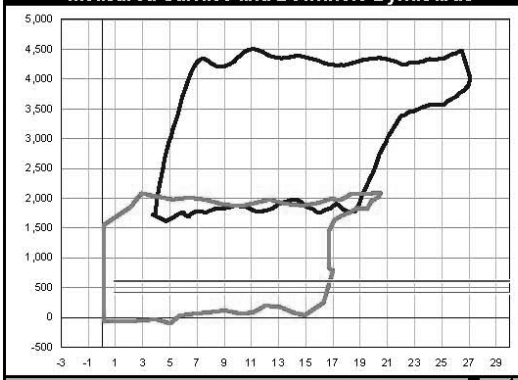
Pump Fill Monitor	86 %
Fluid Fill Monitor	86 %
Gas Fill Monitor	0 %

Diagnostics

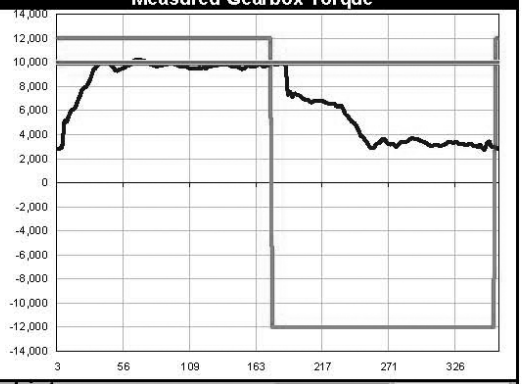
Balance	ADD WEIGHT
Gearbox Load	100.71%

CYCLE DATA -- 1 cycle

Measured Surface and Downhole DynaCards



Measured Gearbox Torque



Feature List

ENABLED | DISABLED

Gearbox Torque Limiting	**Simple Pump-Off Controller**	Cold Start Controller	Speed Profiler Control	Rod Load Limiting Controller	**Pump Fillage Optimizer**	**Auto Fill Trigger Levels**	Flat Power Control	**Auto Restart**	EOP Controller
Bridle Separation Control	Dwell Pump-Off Controller	**Allow Operation Above Base RPM**	Power Economizer Control	Rod Damping Controller	Power Limiting	User SPM Adjust REVERSE	Calendar and/or Timer Control	Xless Referencing	Casing Valve Controller

Figure 8—Well Report Summary Page

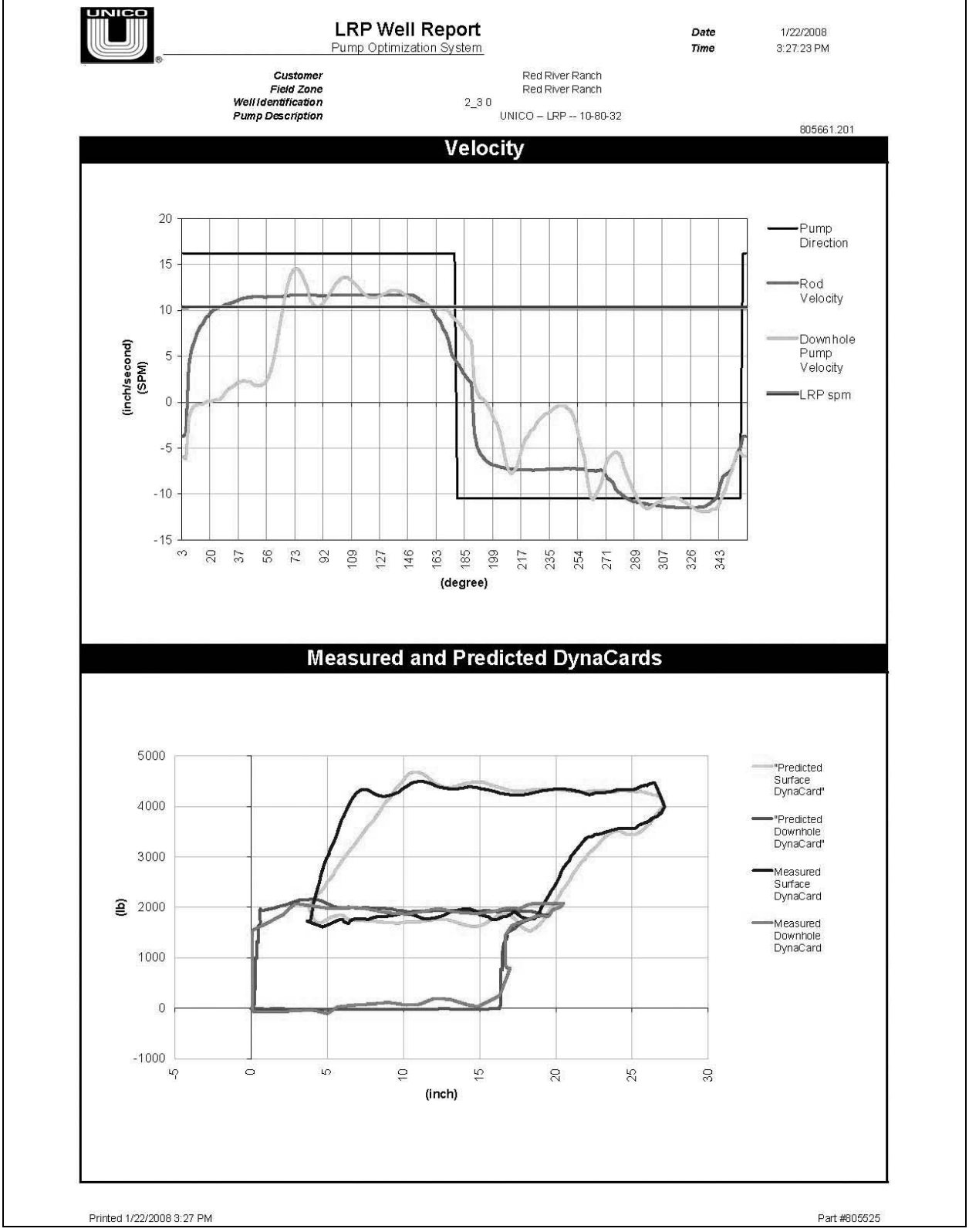


Figure 9—Well Report Velocity and DynaCard Page

LRP Well Report

Pump Optimization System

Date	1/22/2008
Time	3:27:23 PM

Customer	Red River Ranch
Field Zone	Red River Ranch
Well Identification	2_3 0
Pump Description	UNICO -- LRP -- 10-80-32

805661.201

Pumping Unit

S Rod Stroke	24.236 in
Structural Imbalance	-160 lb
Air Balance Compression Ratio	1.000 gain
Gearbox Efficiency	90.0 %
API Counterweight Effect	3,191 lb
Measured Counterweight Effect	-17 lb
Counterweight Effect	0 lb
Rotary Inertia	0.44 in-lb-sec^2
DynaCard Load Offset	0 lb
Dynacard Tilt Offset	0 lb
Downhole Tilt Offset	0 lb
Pump Rate Monitor Adjust	0 %
LRP Stroke ID	29.736 in
LRP Up Position	27.736 in
LRP Down Position	3.500 in

Well Identification Results

Counterweight Effect	0 lb
Rotary Inertia	0.44 in-lb-sec^2
DynaCard Load Offset	0 lb
Pump Counterbalance	-3179 lb
Counterbalance Error	0 in-lb
Counterbalance Action	MORE WEIGHT
Well ID State	COMPLETE
Well ID Date	2008.0122 yyyy.mmdd
Well ID Time	14.40 hh.mm

Rod and Pump

Rod Length	1,417 ft
Pump Depth (TVD)	1,417 ft
Anchor Measured Depth	0 ft
Tubing Outer Diameter	2.875 in
Casing Inner Diameter	5.000 in
Plunger Diameter	2.000 in
Plunger Length	24.000 in
Plunger Clearance	0.014 in
Plunger Leakage	3 bpd
Plunger Efficiency	96.4 %
Rod Sections	TWO
Rod Section 1	0.750 x 1401 STEEL
Rod Section 2	1.250 x 16 STEEL
Water Cut	100.0 %
Oil Specific Gravity	30.0 API
Water Specific Gravity	1.049
Fluid Viscosity	50 centipoise
Tubing Pressure	9 psi
Casing Pressure	15 psi
Rod Weight in Air	2,354 lb
Rod Weight Buoyant	2,064 lb
Rod Friction	266 lb
Fluid Level Offset	0 ft
API Max Fluid Load	2,003 lb
Tubing Stretch	0.5 in

Drive and Motor

Motor Rated Power	10.00 hp
Motor Rated Current	11.90 Arms
Maximum Current	28.00 Arms
Cold Start Current Limit	0.00 Arms
Warm Current Limit	0.00 Arms
Final Current Limit	0.00 Arms
RMS Current Foldback	DISABLED
Base Rpm	1,745 rpm
Motor Max RPM	2,400 rpm
Motor Max SPM	15.1 spm
System Gain	33.5 1/sec/sec
System Wn	10.0 rad/sec
Motor Max Torque	74.31 ft lb
Cold Start Torque Limit	100.00 % max
Warm Torque Limit	100.00 % max
Final Torque Limit	0.00 % max
Accel Time	0.750 sec
Decel Time	0.750 sec

Optimizer

Fill Algorithm Select	PUMP LOAD
Up Maximum Spm	12.0 spm
Up Minimum Spm	2.5 spm
Down Maximum Spm	12.0 spm
Down Minimum Spm	2.5 spm
Optimize Target Fill	88 %
Optimize kp	0.030 %
Optimize ki	3.000 gain
Optimize Start spm	7.0 spm
Optimize Down Boost	0 %
Pump Fill Monitor	86 %

Figure 10—Well Report Detail Page

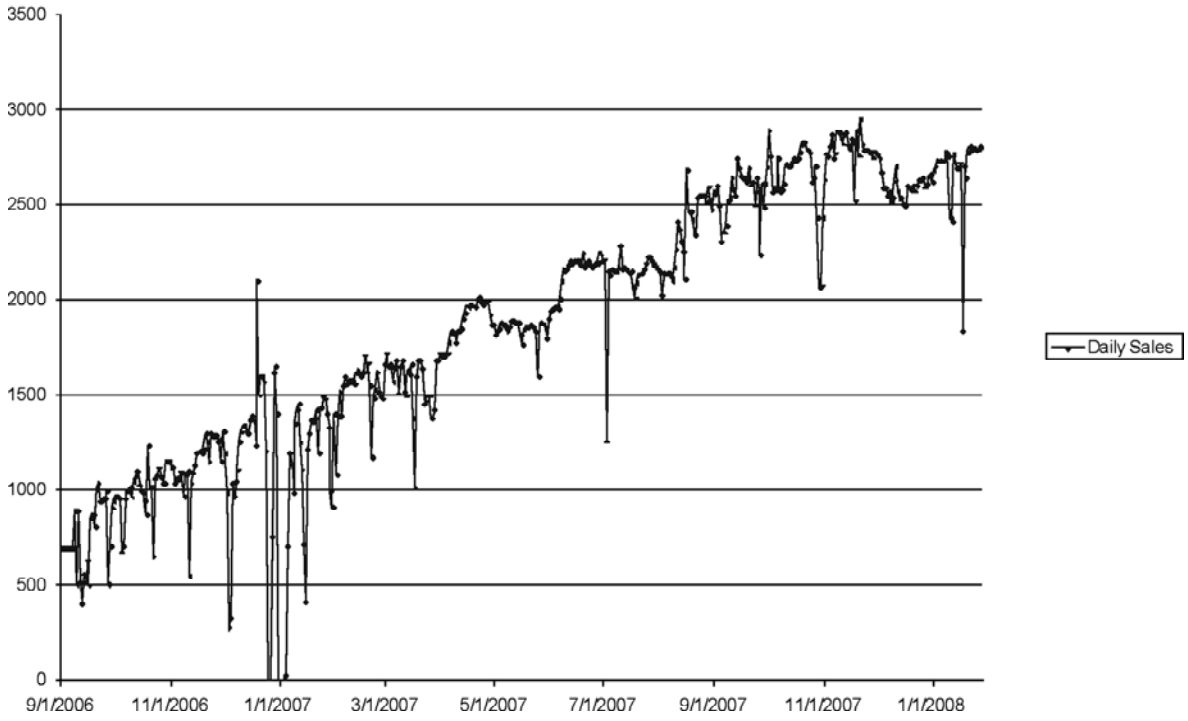


Figure 11—Red River Ranch Daily Production

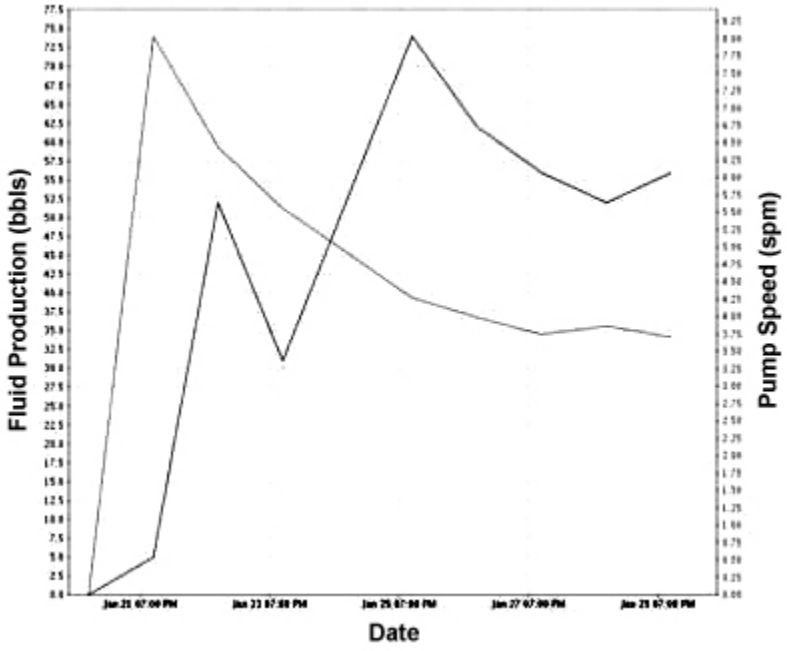


Figure 12—Pumping a Well Down Without Operator Intervention