A SIMPLE LOW COST SOLUTION FOR DYNAMOMETER ANALYSIS

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ABSTRACT

A simple low cost dynamometer has been developed to obtain qualitative dynamometer cards for rod-pumping wells. The dynamometer installs on the polished rod in a matter of seconds and transmits data to a portable computer via wireless communications.

The dynamometer measures rod stretch through each stroke of the pumping cycle. The data is sent to the portable computer using wireless technology therefore eliminating troublesome cables. The wireless design allows technicians to perform dynamometer surveys in their vehicle up to 300 feet from the well.

The qualitative dynamometer can determine pump off conditions, down hole pump conditions and rod string problems. Quantitative data can be obtained by using software available from Theta Enterprises.

The dynamometer is a low cost alternative to high cost, complicated systems.

BACKGROUND

Gathering dynamometer cards typically requires standing a well off and attaching a load cell above the carrier bar and below a clamp to obtain polished rod loads. A position transducer is then attached to the polished rod to measure position of the rod string. Cables from the transducers are connected to a device to collect the load and position data and send them to a computer for storage and interpretation. This process can become cumbersome, time consuming and dangerous to the operator of the equipment. The low cost wireless dynamometer was developed to ease the installation of the load transducer and avoid the entanglement of cables on wellhead equipment. The wireless dynamometer gathers load data on the polished rod and sends it via wireless technology to the portable computer which can be located up to 300 feet from the well. Position is determined by a sensor mounted on the polished rod which determines the bottom of stroke for the pump cycle. Inferring a sine wave for polished rod position avoids using an analog position transducer. The dynamometer card that is obtained is qualitative and can quickly show if a well is pumped off, tagging up or down, and various conditions of the pump.

DESCRIPTION OF OPERATION

The wireless dynamometer uses Bluetooth technology to send and receive data from the portable computer. Bluetooth wireless technology is a short-range communications system intended to replace the cables connecting portable and or fixed electronic devices. The key features of Bluetooth wireless technology are robustness, low power and low cost. The Bluetooth core system consists of an RF transceiver, baseband and protocol stack. The system offers services that enable the connection of devices and the exchange of a variety of data classes between these devices.

Bluetooth requires that a low-cost transceiver chip be included in each device, the dynamometer and the portable computer. The transceiver transmits and receives in a previously unused frequency band of 2.4 GHz that is available globally (with some variation of bandwith in different countries). Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 300 feet (Class 1 device). Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification is provided.

The Bluetooth technology got its unusual name in honor of Harald Bluetooth, king of Denmark in the mid-tenth century.

The wireless dynamometer uses a self-contained microcontroller to sample the output of a pair of strain gauges clamped to the polished rod and precisely times the duration of the polished rod stroke. It then uses this timing to wirelessly transmit 512 samples of the polished rod stretch during the next stroke interval, punctuated by the elapsed time in milliseconds to separate one set of samples from the next.

The relationship between the microscopic rod stretch and instantaneous load on the rod string at the surface is surprisingly linear. The gain and offset of the output signal conditioning can be controlled remotely so the load range will span near the full-scale output. The unit does not use a position transducer, but derives an implied position as a function of elapsed time during each stroke.

Data is automatically sent when a complete stroke timing occurs, and continues until the bottom of stroke signal stops.

Commands can be sent to the unit to cause it to output static loads while the pumping unit is not running, to conduct valve leakdown tests. Each series of outputs are spread out over a 3 minute interval. The test can be repeated as often as required, to catch intermittent valve problems.

ADVANTAGES

Experience has shown that for many of the dynamometer surveys run, a qualitative survey is sufficient. The wireless dynamometer is an excellent alternative to high cost, complicated quantitative dynamometer systems. With a qualitative dynamometer, operators can determine whether or not a well is pumping off and the condition of the subsurface pump. Also, leaking tubing and other pumping system component problems can be easily and quickly assessed from a qualitative dynamometer survey.

Safety – Installing the wireless dynamometer on the pumping system does not require separating the rod clamp from the carrier bar. The wireless unit clamps on the rod string in a matter of a few seconds. The wireless design allows technicians to perform the surveys inside their vehicle up to 300 feet away so employee exposure to operating equipment is greatly reduced. The simplicity of the wireless dynamometer reduces the time technicians are on location.

Convenience – The wireless design eliminates data and power cables that can become entangled on fences, wellheads and personnel. Data is transmitted via wireless technology to a portable computer up to 300 feet away. Dynamometer surveys can be stored in the portable computer for later analysis or distribution. The unit is battery powered and allows for six hours of continuous operation. Charging the battery between surveys will ensure that the unit will always be ready to operate.

Low Cost – Acquisition costs for the wireless dynamometer are a fraction of the cost of quantitative dynamometer systems currently available. Less time is required for technicians to survey wells, increasing their efficiency and productivity.

Quantitative Data – Quantitative data and sub surface dynamometer cards can be obtained from the wireless dynamometer by using software from Theta Enterprises. This software produces accurate inferred system loads and down hole information.

OPERATIONAL EXAMPLES

Figure 1 shows the wireless dynamometer attached to the polished of the pumping unit. A sensor is attached below the dynamometer which senses a magnet mounted on the well head.

Figure 2 is a screen shot from the portable computer showing a well that is pumping off. These are 7 consecutive strokes of the pumping unit overlayed.

Figure 3 is a screen shot from the portable computer showing a valve check operation. This is a plot of the load versus time. Traveling or standing valve leaks can be determined by using this feature of the dynamometer.

Figure 4 is a screen shot from the portable computer showing a well with parted rods.

Figure 5 is a screen shot from the portable computer showing a well with intermittent seating of the traveling valve. The load on upstroke shifts up and down, which indicates the traveling valve is not holding.

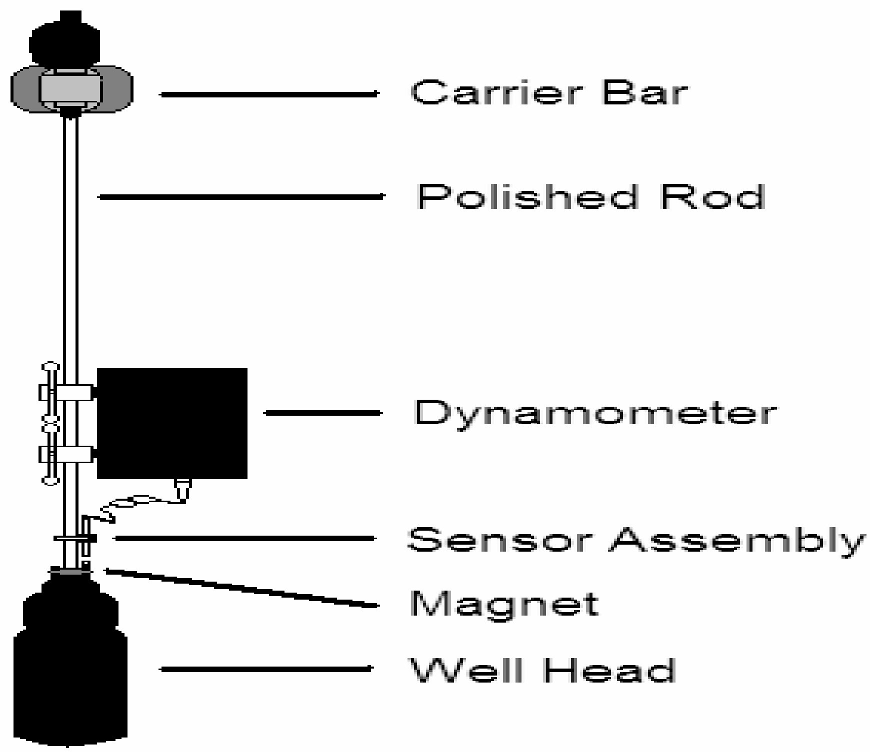

Figure 1 - Dynamometer Attached to Polished Rod

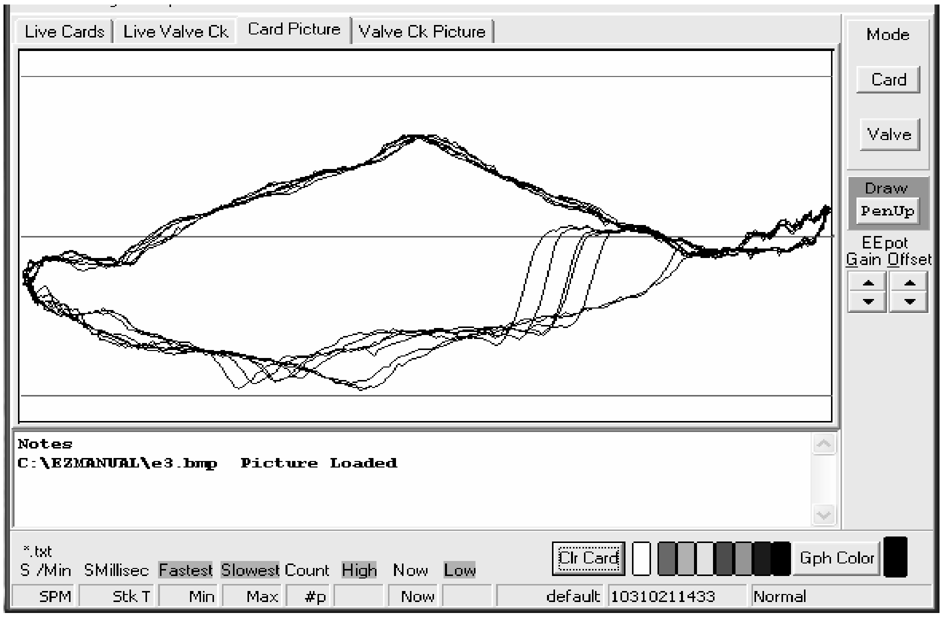

Figure 2 - Well Pumping Off

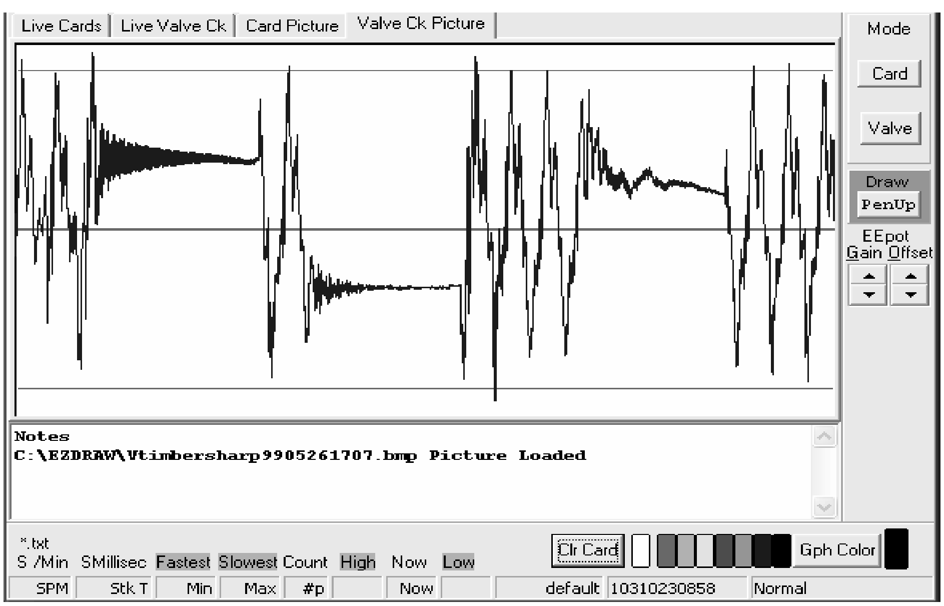

Figure 3 - Valve Checks

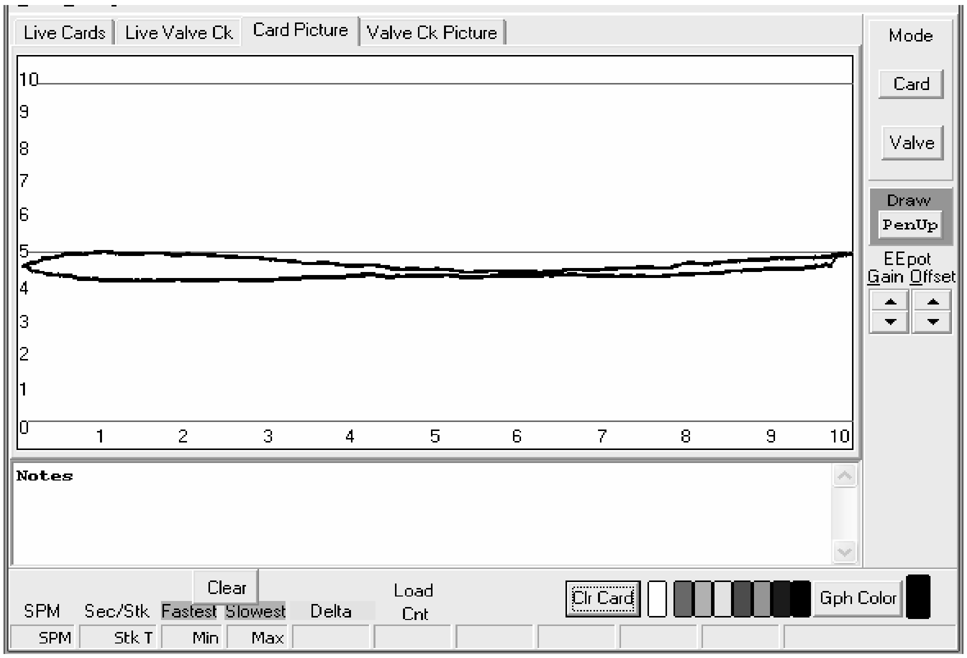

Figure 4 - Parted Rods

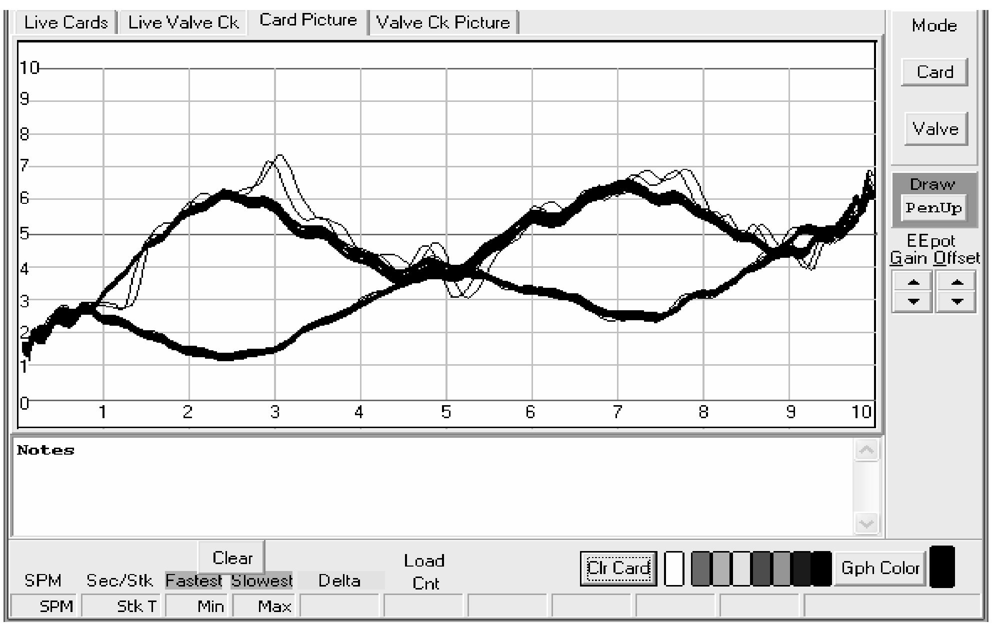

Figure 5 - Intermittent Seating of Traveling Valve