

Oil & Gas Automation

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INNOVATIVE APPROACHES TO EXPLORATION AND PRODUCTION

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Unico, Inc.
3725 Nicholson Rd.
P. O. Box 0505
Franksville, WI
53126-0505
262.886.5678
262.504.7396 fax
oilgas@unico.com

Technically Speaking



Automating Fluid Level Measurement in Electric Submersible Pumps (ESPs)

by Rick Tennesen *oil and gas division manager*

Casing fluid level is an important parameter in the use of electric submersible pumps (ESPs) for oil and gas production. A well operator continually faces a balancing act between production and protection. Production must be increased without



lowering the fluid level to the point where the pump is starved of the fluid it needs for cooling. If the fluid is lowered too far, an underload or pump-off condition will shut the pump down, leaving the well productionless, potentially for hours, while the tube drains and refills.

Operators of ESP systems use various methods to gauge fluid levels. One of the more popular methods is the periodic use of an instrument like an Echometer to acoustically "shoot" fluid levels. This method requires manual intervention, is subject to human error, and does not provide the continuous measurement required for closed-loop control of fluid level. In critical applications, downhole pressure sensors may be used to overcome these limitations. Downhole gauges, however, are expensive and often disappointingly unreliable. The ideal solution would be an automated means of measuring fluid level that would eliminate the additional hardware altogether.



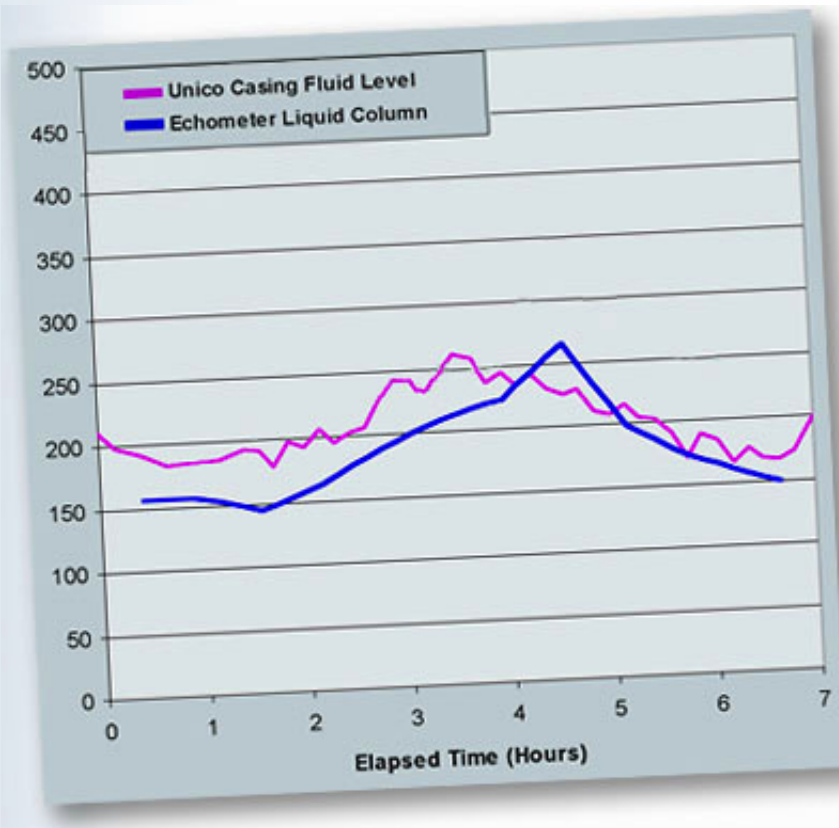
Unico ESP drives offer one such solution. They employ a unique, patented method of determining casing fluid level without the use of a downhole



pressure sensor. The drives are designed for precise measurement of downhole motor speed and torque. Fluid level estimation software within the drive uses these precise measurements to periodically probe for pump differential pressure. In turn, that pressure is used, along with other well and pump parameters, to estimate pump fluid flow, pump intake pressure, and casing fluid level. In addition, the drive also provides closed-loop regulation of casing fluid level using its casing fluid estimate.

Field tests have been done to assess the performance of sensorless fluid level measurement. In one test, conducted on an ESP well in western Texas, fluid level measurements from the drive were compared against those of an Echometer.

To evaluate the consistency of the fluid level estimate at different speeds, pump speed was varied at 36 minute intervals from 64 Hz down to 58 Hz, then back up to 68 Hz in 2 Hz increments. The drive sampled the casing fluid level every nine minutes, and an Echometer shot was taken every 36 minutes at the end of each interval. The results are shown below. Casing fluid level from the Unico drive (pink) is compared to the Echometer equivalent liquid column (blue).



Casing fluid level, as measured by a Unico ESP drive, versus Echometer fluid level measurements at various pump speeds. The sensorless technique provides automated continuous measurement.

The casing fluid level measurements were generally in good agreement with the Echometer estimates of the equivalent liquid column. Varying the pump speed from 58 to 68 Hz had no effect on casing fluid level readings other than what would be expected from the effect of changes in pump flow

during the test. The Unico and Echometer measurements tracked within 40 feet during the tests. There is an adjustment factor in the Unico system that can be used to bring the estimates into better agreement. Using an offset of 20 feet would place the Unico measurements within 20 feet of the Echometer fluid shots. A later test with revised software put it within 25 feet of the Echometer shots and the actual detection of the pump-off or zero-fluid-level condition.

The Echometer readings were somewhat delayed from the Unico measurements, which could be due to potential errors in both methods. The cause of the delay and the relative error magnitudes of the two types of measurement could be resolved by a comparison to a calibrated downhole sensor.

This method of fluid level measurement only requires the base pump head and pump intake depth, parameters that are readily available from well setup data and are not subject to interpretation.

The advantage of continuous, automated measurement of casing fluid level is that the fluid level can be automatically regulated by the drive. Closed-loop fluid level control will be discussed in the next issue of *Solutions*.

To learn more about sensorless fluid level measurement, please [contact us](#).

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Product Watch

New RPC Rod Pump Controller Provides Economical Sophistication



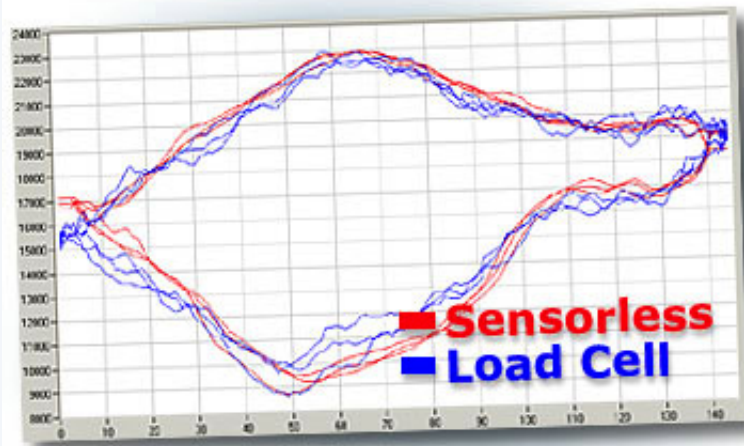
Unico's newly introduced RPC Rod Pump Controller provides advanced pump-off control and monitoring capabilities for sucker-rod pumping systems. The unit offers many of the features of Unico's SRP variable-speed drives in a compact, economical package for use with a separate motor controller.

The RPC system regulates the fluid level in a well by intelligently cycling the pump motor based upon well

inflow. The unit monitors pump fillage by continually evaluating the downhole dynamometer plot and turns the pump off whenever pump fillage

drops below a specified threshold. The controller automatically determines the optimal cycle time. By responding to downhole conditions, the RPC controller improves system efficiency and extends equipment life by running the pump only when necessary.

A unique advantage of the RPC controller is its ability to operate without a load cell. Patented sensorless technology determines polished rod load without the added complexity and expense of hardware sensors. In sensorless mode, the controller determines surface and downhole dynamometer plots, just as it does if a load cell is connected. The unit also accepts a variety of other input sensors, including a beam-position inclinometer, motor current and voltage sensors, and tubing and casing pressure sensors. Motor sensors enable the unit to monitor gear box torque to protect the system from overloading. Pressure sensors are used primarily for data acquisition.



The accuracy of the Unico sensorless method of generating dynamometer plots was measured on a well near Carlsbad, New Mexico, using a polished rod load cell for comparison. Both methods show a peak load of about 23,000 pounds and a minimum load of 9,000 pounds. The dynamic appearance of the two measurement methods is nearly identical.

Additional control features include a utility rate saver feature, automatic restart, adaptive pump fill trigger level, automatic counterbalance check, oil/belt/gearbox service reminders, a pumping system simulator, and more. A digital signal processor (DSP) provides the computational power.

The RPC controller monitors critical well production and performance information and makes it available through its built-in graphical display or via remote telemetry. This information includes real-time and predicted surface and downhole dynamometer graphs; daily gauging of fluid production, leakage, pump speed, and pump fill; rod, pump, gear box, fluid,


and power data; fault and event logging; a user-configurable data sampler, and more. Remote communication options include wireless, radio, cellular, and satellite. An antenna connection is provided.

Producers can keep tabs on daily operations without having to physically visit each well site using Unico's optional GMC™ Global Monitoring and Control service. The GMC™ system combines real-time wireless data collection with a sophisticated hosted front end to provide round-the-clock Web-based monitoring, historical analysis, automated reporting, and alarm notification for any number of wells. Operators can view data for an individual well, an entire field of wells, or for all their fields simultaneously. The RPC controller can also be interfaced with popular third-party head-end software packages, such as Case and Theta.

The RPC unit can be powered by single-phase 115/230 V AC or by 460 V AC with an optional transformer. Configurable I/O points with plug-in converters accommodate a wide variety of AC and DC voltages as well as relay contact outputs.

RPC units have been designed to withstand the harsh environments of the oil patch. A rugged NEMA 4R polycarbonate housing protects the control, while a see-through acrylic window shields the liquid-crystal display while still allowing operator access to the keypad and pushbuttons.

To learn more about the RPC Rod Pump Controller, please [contact us](#).

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What's Coming Up

In Future Issues...

Look for the following articles in upcoming issues of *Oil & Gas Automation Solutions*:

- Controlling casing fluid level in ESPs
- Field tests of methods to eliminate rod pump gas locking and interference
- Reducing power consumption and improving power factor of beam pumps
- Using a torque economizer mode to improve efficiency and reduce gearbox stress
- Control options to ride through power disturbances
- Loss of methane gas production due to overpumping CBM wells
- Use of low-profile CRP® and LRP® pumping units with traveling

irrigation systems

- Air counterbalance increases LRP® linear rod pump lift capacity

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