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SRP Calculator revised

Unico's SRP Calculator has been updated for Rotaflex and phased-crank pumps and deviated wells.

Rotaflex controls

Embedded well control designed to maximize potential of Rotaflex units.

In future issues

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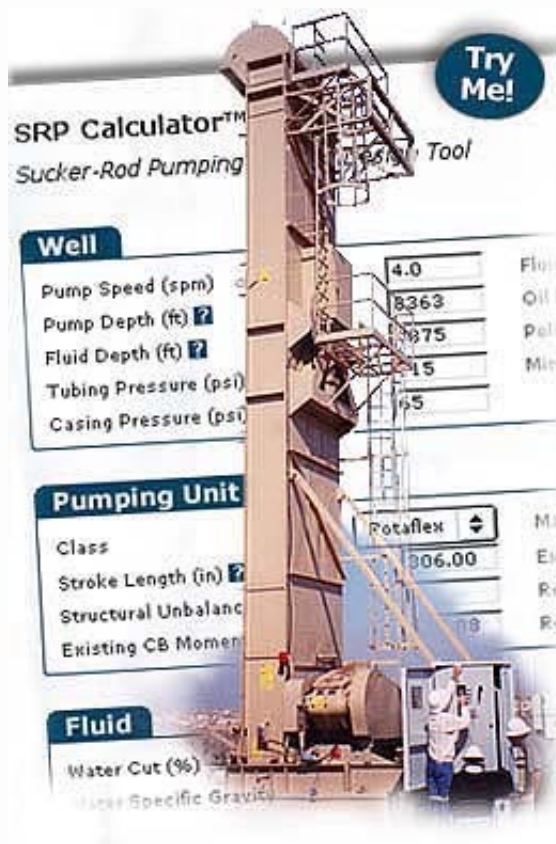


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Special Edition

SRP Calculator™ Enhanced for Rotaflex Pumps, Phased-Crank Pumps, and Deviated Wells



Our last issue of *Solutions* introduced the SRP Calculator™, a convenient design tool for analyzing the performance of sucker-rod pumping systems. That initial version of this free online calculator provided quick and easy analysis of Class I (conventional) and Class III (Mark II) pumping-unit geometries applied to vertical wells.

We've made several improvements to the SRP Calculator™ to allow it to be

used with a broader range of artificial-lift applications. Pump total vertical depth has been separated from total rod string length to provide a simple method for estimating the performance of deviated wells. The rod configuration has been expanded with separate entries for tapered rod strings and sinker bars. Tapered rods of up to three sections can be conveniently accommodated. Calculations of rod stress at the top of each section have also been added. The SRP Calculator™ has also been expanded to include Rotaflex pumping units as well as phased-crank units like the Torque Master, Reverse Mark, or Maximizer II.

The results from the SRP Calculator™, the Rodstar program from Theta

Enterprises, and actual field test results of a Rotaflex pump are summarized in the table below. Most SRP Calculator™ Rotaflex calculations are reasonably close to both Rodstar estimates and the actual field test results. The major difference was in the maximum gearbox torque measured in the field. The actual gearbox torque measured in the field includes the effects of motor speed fluctuations, which are not accounted for in Rodstar or the SRP Calculator™. In that sense, those two programs make conservative estimates of gearbox torque compared to what is likely to occur in actual installations. The SRP Calculator™ results shown in the table below also compare reasonably to the Rodstar and API method (RP 11L) calculations for a Reverse Mark phased-crank pumping unit.

The SRP Calculator™ is not intended to replace the detailed analysis available from commercial rod-pump simulation programs. In many cases, however, detailed analysis is unnecessary and often greatly exceeds the precision of field measurement. Unico's SRP Calculator™ provides simple well analysis of conventional, air-balanced, phased-crank, Mark II, and Rotaflex pumps to help you decide if a more detailed analysis is required.

Rotaflex Analysis Comparison *(8,363 ft. well)*


Calculation	Unico SRP Calculator	Theta Rodstar	Unico/Rodstar	Field Test	Unico/Test
Fluid Production Rate (bpd)	479	517	-7%	493	-3%
Oil Production Rate (bpd)	374	403	-7%	385	-3%
Polished Rod Power (hp)	33.8	36.1	-6%	35.8	-5%
Minimum Motor Size (hp)	50.0	50.0	0%	—	—
Required Balance (in-lb)	360,364	359,700	0%	357,884	+1%
Existing Balance Effect (lb)	21,690	21,800	-1%	21,690	0%
Required Balance Effect (lb)	21,840	21,800	0%	21,690	+1%
Max. Gearbox Torque (in-lb)	158,828	169,000	-6%	140,800	+13%
Buoyant Rod Load (lb)	17,022	17,201	-1%	17,114	-1%
Maximum Rod Load (lb)	31,316	31,871	-2%	31,000	+1%
Minimum Rod Load (lb)	12,365	11,739	+5%	12,300	+1%
Upper Section Stress (psi)	39,550	40,452	-2%	39,148	+1%
Middle Section Stress (psi)	37,302	37,835	-1%	—	—
Lower Section Stress (psi)	31,647	30,942	+2%	—	—
Pump Stroke (in)	267.52	288.00	-7%	277.0	-3%

Reverse Mark Analysis Comparison *(8,000 ft. well)*

Calculation	Unico SRP Calculator	Theta Rodstar	Unico/Rodstar	API RP 11L	Unico/API
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Fluid Production Rate (bpd)	318	324	-2%	331	-4%
Oil Production Rate (bpd)	64	65	-2%	66	-4%
Polished Rod Power (hp)	25.6	26.8	-4%	21.4	+20%
Minimum Motor Size (hp)	50.0	50.0	0%	—	—
Required Balance (in-lb)	1,719,610	1,659,720	+4%	—	—
Existing Balance Effect (lb)	22,844	23,367	-2%	—	—
Required Balance Effect (lb)	21,816	21,506	+1%	21,706	+1%
Max. Gearbox Torque (in-lb)	812,028	817,000	-1%	753,406	+8%
Buoyant Rod Load (lb)	15,906	15,909	0%	15,636	+2%
Maximum Rod Load (lb)	30,578	30,550	0%	28,007	+9%
Minimum Rod Load (lb)	10,456	10,043	+4%	10,389	+1%
Upper Section Stress (psi)	38,689	38,770	0%	—	—
Middle Section Stress (psi)	36,922	34,818	+6%	—	—
Lower Section Stress (psi)	35,103	31,334	+12%	—	—
Tubing Stretch (in)	1.07	1.10	-3%	1.10	-3%
Pump Stroke (in)	124.61	130.00	-4%	128.30	-3%

Give the SRP Calculator™ a try at www.unicous.com/oilgas/srpcalc.php and let us know what you think. We would appreciate any [feedback](#) that can make this tool more useful for you. Check future issues of *Solutions* or our Web site for enhancements to the SRP Calculator™ as well as other new artificial-lift design tools. You may also want to inquire about our artificial-lift drive systems that incorporate complete dynamic analysis, including dynamometer cards and gearbox torque plots.

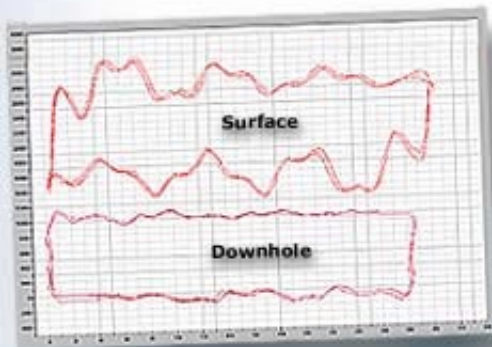
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Product Watch

Embedded Well Control Taps the Potential of Rotaflex Pumping Units

Unico's Sucker-Rod Pump (SRP) control software has been engineered to tap the potential of Rotaflex artificial-lift systems. Rotaflex pumping units are typically used on deep or gassy wells because of their long, slow strokes. In addition to modeling Rotaflex geometry, the software offers a host of sophisticated features designed to increase efficiency, boost production, and extend equipment life. The software, which is embedded within a Unico drive, provides a racetrack mode, automatic corner anticipation, sensorless surface and downhole dynamometer graphs, pump fill detection and control, gearbox torque protection, and more.

The innovative *racetrack mode* and *automatic corner anticipation* features work hand-in-hand to optimize each stroke. Racetrack mode controls the speed of the upstroke, downstroke, and cornering portions of a cycle independently, allowing the pump to speed up during the straight portions and slow down while cornering to protect the pumping system. While Rotaflex units are typically geared to run at a constant 4.5 spm at 1,150 rpm base speed, Unico's constant-power control extends the motor speed range beyond base speed to 1,750 rpm (6.8 spm) during the upstroke and downstroke straight sections. Since the Rotaflex unit is physically limited to 4.5 spm in the corner, the controller anticipates the corner by automatically slowing the motor to the preset cornering speed at the appropriate time. In this example, racetrack mode increased the average pumping speed to 6.0 spm, resulting in a 33% increase in production. Given typical inflow and motor torque limitations, more modest production increases of 10% to 15% are commonly obtained.



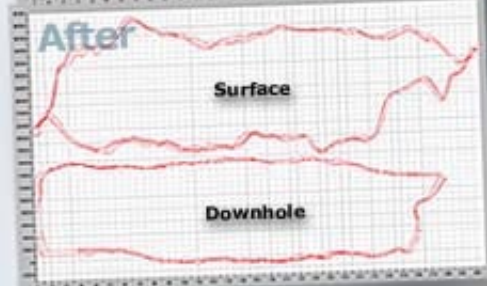
Sample dynamometer graphs

1

The SRP program also generates surface *and* downhole dynamometer graphs without requiring external position and load sensors. Using these graphs, the controller can regulate pump fill in real time as well as provide important diagnostics about the pumping system. This is especially useful for wells that are pumping off or suffering from gas interference.



2




3

Figure 1 shows the surface and downhole dynamometer plots from a recent Rotaflex start-up. Figures 2 and 3 show the effects of controlling pump fill with Unico's *production optimizer*. Figure 2 shows the well without the optimizer, while Figure 3 illustrates the benefit of slowing the pumping unit to increase pump fill.

Effect of optimizing pump fill

Other SRP software features are engineered to save energy, protect the gearbox from overloading, simplify counterbalance setup, prevent bridle separation, detect belt slip, generate predicted dynamometer graphs, as well as to monitor fluid flow, pump stroke, cumulative production, pumping efficiency, and input power.

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What's Coming Up

In Future Issues...

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

- Taking advantage of utility rate structures to reduce artificial-lift energy costs
- Field tests of methods to eliminate rod pump gas locking and interference
- Using a torque economizer mode to improve efficiency and reduce gearbox stress
- Power loss components in a typical rod pumping system
- A novel way of conceptualizing the effectiveness of artificial lifts
- Reducing power consumption and improving power factor of beam pumps
- Detecting stick/slip oscillations that fatigue rod-string couplings and reduce energy efficiency of PCPs

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