SRP

Sucker-Rod Pump Drive

UNICO

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Overview

Unico's Sucker-Rod Pump Drive (SRP™) provides superior control of conventional, air-balanced, beam-balanced, phased-crank, Mark II, Reverse Mark, and Rotaflex artificial lifts. The drive integrates motor control, speed optimization, logic, pump fill control, and rod load control into a single, compact solution that increases production, improves energy efficiency, and enhances the reliability of both new and existing pumping systems.

Multiple Constraint Optimization

At any instant during the life of a well, and even within a pump cycle, there is a single constraint that limits production. Production can be maximized without compromising efficiency or reliability by forcing the system to operate at the particular constraint limiting production at each instant of time. Determining the applicable limits and moving smoothly between them in real time is a key advantage of the Unico system. Models of all the system elements are run in real time at the wellhead to detect appropriate limits and enforce associated control strategies. At different points in the pump cycle, the system may be limited by maximum motor speed, motor thermal capacity, power demands, gearbox maximum torque, rod maximum load, rod fall velocity, or pump fill. Multiple constraint optimization is particularly beneficial in applications with variable inflow conditions, such as those found in coal-bed methane, high gas/oil ratio, and thermally stimulated wells.

Sophisticated Modeling

Embedded mathematical models of drive, motor, pump unit, rod string, pump, flow line, tubing, casing, fluid, and reservoir use component specifications and well completion information along with field setup parameters to monitor pumping system operation. Identification routines automatically determine installation-dependent system parameters, including those of the electric motor, pumping unit, rod string, and downhole pump. The models capture the thermal, mechanical, electrical, and hydraulic behavior of the pumping system to control the pumping process with greater precision than ever before.

Sensorless Operation

The drive uses a number of unique methods for precisely determining polished rod and downhole pump position, velocity, and load without requiring external rod position or load sensors. These sensorless system variables can be observed through monitor displays or recorded as time-based graphical plots of motor velocity, motor torque, pump speed, gearbox torque, rod velocity, rod position, rod load, pump velocity, pump position, and pump load, as well as dynamometer plots of surface and downhole conditions.

Overview *(continued)*

Pump Speed Control

The drive provides a number of options for controlling pump speed. Speed commands can be selected from a number of sources, including potentiometer adjustments, keypad presets, serial data communications, and internal optimization controllers. Single-, dual-, and triple-speed control options allow pump upstroke, downstroke, and cornering speeds to be adjusted independently. Speed changes can also be programmed to occur at selected crank angles or rod positions. Rotaflex cornering speed control automatically calculates braking distances to get from straightaway to cornering speeds as well as points for accelerating out of the corners. The motor can be operated at up to twice base speed at constant power. This allows the overall gear ratio to be increased, thereby providing increased low-speed torque while smoothing gearbox torque at high pumping speeds.

Pump Fill Control

The drive accurately determines and regulates the percentage of pump fill without requiring separate sensors or control hardware. Rather than simply stop a pump completely during a pump-off condition, the drive adjusts upstroke and downstroke speeds to maintain a target fill value and maximize production. This allows the pump to automatically adapt to changing well inflow characteristics. This control eliminates fluid pound, reduces peak rod load, prevents standstill sand infiltration, eliminates stresses associated with start/stop cycling, and improves pumping efficiency by reducing viscous friction. A pump-off controller allows the pump to dwell for a programmable period for wells with low inflow. A dwell period minimum pump speed can be used to prevent sanding in the well.

Rod Load Control

A rod string calculator establishes rod load and resonance parameters for continuous, coupled, straight, and tapered rod configurations. Rod load is corrected for deviated completions, and rod friction is automatically identified. Rod and pump monitors continuously measure and display polished rod and downhole pump loads, velocities, and positions. Rod force can be measured directly from a load cell or internally computed without the need for external instrumentation. A rod load limiter automatically adjusts downstroke speed to eliminate rod float by maintaining minimum road load while maximizing production. Independent maximum and minimum rod load limits can be preset to reduce rod stress. Rod load damping can be used to suppress oscillatory rod force excursions and improve the efficiency of the pumping system without the need for specific rod load limits.

Bridle Separation Control

A bridle separation limiter prevents rod float by automatically adjusting downstroke speed for minimum rod load. A limit switch can be used to detect bridle separation to automatically correct the pump speed and record a separation event.

Dynacard Generator

A motor torque monitor and pumping-unit geometry are used in place of a load cell to plot actual surface dynamometer graphs using either a personal computer or Palm-type handheld. No external load cell is required. The drive also estimates downhole pump stroke and pump flow. Predicted surface and downhole dynamometer graphs are available for diagnosing well and pump problems on site.

Power Monitoring and Control

The drive provides detailed information on energy usage within the pumping system, including system input power, motor output power, polished rod power, and pump lift power. An input power meter displays cumulative energy consumption, while a pumping efficiency monitor shows the effectiveness of input energy utilization for production of useful lift work. Peak and regenerative power limiters allow the maximum and regenerative power supplied by the drive to be conserved. Power flow control can be used to smooth power flow, reduce gearbox stress, and increase the efficiency of the pumping without specifying specific pump power limits. A power flow optimizer can be used to maximize production for highly variable inflow conditions by operating the drive and motor at their maximum thermal capacities.

Overview *(continued)*

Production Monitors
A pump flow monitor provides a continuous estimate of flow without the need for additional instrumentation. Pumping speed and pump effective volume are used to estimate the actual production rate. Pump flow is totaled in a resettable production accumulator. Estimated well production is displayed for the operator and is available for remote well monitoring through a serial communication port.

Fluid Level Monitor
A fluid level monitor provides a continuous estimate of level from pump load, fluid properties, tubing pressure, and casing pressure. Tubing and casing pressures can be entered as parameters for relatively fixed pressures or input from analog sensors for significantly variable pressures.

Gearbox Monitor and Limiters
A crank position monitor provides a continuous reading of the angle of the crank shaft. The crank angle is referenced by a proximity switch, limit switch, or inclinometer. Gearbox torque is monitored and can be limited to protect against damaging overload conditions. A belt slip monitor detects and reports excessive drive belt slippage or breakage. A starting torque manager eliminates inrush currents and extends the life of the system by reducing the violence associated with starting the pump.

Counterbalance Monitor
A counterbalance monitor determines the existing counterbalance effect and warns of counterbalance problems. An associated counterbalance assistant makes it easy to adjust the counterweights to minimize gearbox stress and energy consumption.

Automatic Restart
The drive can automatically recover from fault conditions and intermittent power outages to ensure continuous operation with unattended wells. Start/stop events are automatically logged for subsequent retrieval.

Data Capture
A data sampler captures real-time information for generating torque, velocity, and position plots as well as surface and downhole dynamometer cards. A data logger collects time-stamped fault, warning, and event logs that can be viewed through the keypad/display, uploaded to a personal computer, or retrieved by a network server. Typical events include start, stop, mode change, power-up, power loss, overvoltage, overcurrent, bridle separation, belt slip, balance fault, low load, and high load. Pump fill and speed are periodically logged for subsequent trend analysis.

Data Communications
Several industry-standard serial protocols are available for communicating with popular programmable controllers as well as personal computers or network servers. Available protocols include ANSI, Modbus RTU, Modbus Plus, ControlNet, Profibus, and Ethernet. Optional software is available for monitoring the pumping system using an iPhone or iPad handheld device, Windows-based personal computer, or network server. User-programmable reports can be generated using software that connects system parameters to Excel spreadsheets.

System Simulation
A pumping system simulator allows actual or hypothetical pumping-system setup parameters to be evaluated over a broad range of operating conditions. Simulations can be run in the field using the drive without actually powering the motor or on the desktop using a Unico well monitor/emulator unit.

Features

Control

Speed References
- Analog potentiometers
- Keypad/display presets
- Serial communications
- Optimization controllers

Speed Control
- Single, dual, or triple speed
- Crank angle speed-change set points
- Rotaflex cornering speed
- Extended speed control
- Speed profile control

Torque Control
- Starting torque manager
- Gearbox torque economizer

Pump Fill Control
- Pump off control
- Pump fill optimizer
- Gas interference limiter

Power Control
- Maximum power limiter
- Regenerative power limiter
- Power demand economizer
- Power flow optimizer

Pump Types
- Conventional
- Phased-crank
- Air-balanced
- Rotaflex
- Mark II
- Reverse Mark

System Models
- Drive
- Motor
- Pumping unit
- Rod string
- Flow line
- Tubing
- Casing
- Downhole pump
- Fluid
- Reservoir

Protection

Motor
- Motor current limiter
- Motor torque limiter
- Motor thermal limiter

Gearbox
- Gearbox torque limiter

Stuffing Box
- Gas interference limiter

Tubing
- Rod minimum load limiter

Rod
- Bridle separation limiter
- Rod maximum load limiter
- Rod minimum load limiter
- Pump fill controller

Setups

- Motor nameplate data
- Pumping unit geometry
- Gearbox torque limit
- Rod string configuration
- Rod string load limits
- Tubing configuration
- Pump characteristics
- Fluid properties
- Reservoir properties

Displays

Motor
- Motor voltage
- Motor current
- Motor speed
- Motor torque

Mechanical
- Gearbox torque
- Counterbalance
- Crank speed
- Crank angle
- Belt slip
- Bridle separation

Rod
- Rod velocity
- Rod position
- Rod load
- Rod friction

Pump
- Pump velocity
- Pump position
- Pump load
- Suction pressure
- Discharge pressure
- Pump fill

Well
- Tubing pressure
- Casing pressure
- Fluid level
- Fluid flow
- Fluid production

Power
- Power meter
- Input power
- Motor power
- Rod power
- Lift power
- System efficiency

Graphics

- Surface dynacard
- Downhole dynacard
- Gearbox torque plot
- Crank velocity plot
- Rod velocity plot
- Pump velocity plot

Interface

Inputs/Outputs
- Three analog inputs
- Two analog outputs
- Twelve logic inputs
- Six logic outputs
- Optional eight analog inputs
- Optional four analog outputs

Serial Communications
- Local and remote serial ports
- Standard ANSI and Modbus RTU
- Optional Modbus Plus, ControlNet, Profibus, Ethernet
- Windows, iPhone, or iPad
- Optional 900 MHz and 2.4 GHz wireless

Sensor Options
- Crank reference switch
- Beam position inclinometer
- Rod load cell transducer
- Tubing pressure sensor
- Casing pressure sensor

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