Progressive Cavity Pump Drive

UNICO

PCP

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Overview

Unico's Progressing Cavity Pump (PCP) Drive provides a number of features specifically designed for operation of progressing cavity pumps. The drive combines motor and pump control into a single, compact package 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, 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 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 time, the system may be limited by motor voltage, motor current, motor speed, motor torque, motor thermal capacity, power demand, rod string torque, flow line pressure, fluid level, or well inflow. 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 the drive, motor, drive head, 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 motor, rod string, and pump. The models capture the thermal, mechanical, electrical, and hydraulic behavior of the 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 performance parameters from models of the pumping system elements without requiring external surface or downhole sensors. Sensorless system variables including rod speed, rod torque, pump speed, pump torque, fluid flow, fluid level, suction pressure, discharge pressure, and differential pressure can be observed through the drive keypad/display or recorded as circle charts and time-based plots. Fluid level, pump flow, and total production are displayed in selectable engineering units.

Overview
(continued)

Pump Speed Control
The drive provides a number of options for manual, remote, and automatic control of pump speed. Speed commands can be selected from a number of sources including potentiometer adjustments, keypad presets, serial data communications, and internal optimization controllers. The motor can be operated up to twice base speed at constant power. This allows the overall gear ratio to be increased, thereby providing increased low-speed torque without loss of maximum pump speed. Dual motors can be controlled from a single drive for operation of large pumps. The system can be configured for optimization of fluid production, gas production, energy efficiency, and/or power flow.

Production Optimization
Level control maximizes fluid production by regulating the downhole pump inlet pressure. An optional surface flow sensor can be used to automatically locate the point of maximum production while protecting the system from a pump-off condition. A search routine uses an optional gas flow sensor input to automatically select the fluid level that maximizes gas production in coalbed methane pumping applications. Current limit control increases production by raising motor speed during periods of reduced pump load. A power flow optimizer maximizes production from gassy wells by allowing the drive and motor to operate at their maximum thermal capacities.

Pump-Off Control
Pump-off control maximizes well production for any given inflow characteristic. Fluid level over the pump intake is precisely controlled by differential sensing of casing gas and pump intake pressure. A pump-off control allows the pump to dwell for a programmable period of time to protect the pump and to control average flow. A dwell period minimum pump speed can be used to prevent sanding in the well.

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 head, 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.

System Protection
Torque limiting protects the motor from excessive torque loads and the rod string against breakage. Stick-slip oscillation damping reduced rod string fatigue failures. Excess flow line pressure can be used to prevent damaging pump loads. Low speed detection protects the system in case of a stall condition, such as a stuck pump or blocked flow line. Breakaway torque detection identifies pump problems during starting. Low torque detection indicates a rod break, belt failure, or plugged sand screen. Sensing of pump inlet and outlet differential pressure is used to protect the pump from overloading.

Automatic Restart
The drive can automatically recover from fault conditions and intermittent power outages to ensue continuous operation of unattended wells. Auto restart control sequences starting of multiple pumps after power outages to eliminate surges in power demand. Start/stop events are automatically logged for subsequent retrieval.

Energy Savings

A power flow optimizer reduces the electric utility cost for any inflow rate. A cyclic energy optimizer provides additional utility cost reduction by pumping at the maximum efficiency point necessary to achieve required flow. Time-of-use control can be used to minimize on-peak energy demand charges. The drive incorporates an input power meter as well as displays of input power, motor power, rod power, pump power, and average efficiency to aid in utility cost control.

Data Capture

A data sampler captures real-time information for generation of motor, rod, and pump performance charts as well as plots of production information. A data logger collects time-stamped fault, warning, and event logs that can be viewed through the drive 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, low torque, and low speed. A multichannel analog interface option allows data logging of additional well parameters.

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 Palm-type handheld devices and Windows based personal computers or network servers. A wireless interface option allows remote monitoring of system performance and control of pump operation. User-programmable reports can be generated using software that connects system parameters to Excel spreadsheets.

Features

Control

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

Speed Control
- Local speed control
- Remote speed control
- Extended speed control
- Fluid level control
- Pump off control
- Gas flow optimizer

Power Control
- Power demand limiter
- Power flow optimizer
- Time of use optimizer
- Cyclic energy optimizer

System Models
- Drive
- Motor
- Drive head
- Rod string
- Pump
- Flow line
- Tubing
- Casing
- Fluid
- Reservoir

Protection

- Motor current limiter
- Motor torque limiter
- Motor thermal limiter
- Rod string torque limiter
- Pump pressure limiter
- Low torque detector
- Low speed detector

Setups

- Motor nameplate data
- Drive head configuration
- Rod string configuration
- Rod string torque limits
- Tubing configuration
- Casing configuration
- Pump characteristics
- Fluid properties
- Reservoir properties

Displays

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

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

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

Pump
- Pump velocity
- Pump torque
- Suction pressure
- Discharge pressure
- Differential pressure

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

Graphics

- Rod velocity
- Rod torque
- Pump velocity
- Pump torque
- Motor voltage
- Motor current
- Motor speed
- Motor torque

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 and Palm OS
- Optional 900 MHz and 2.4 GHz wireless

Sensor Options
- Fluid flow sensor
- Gas flow sensor
- Suction pressure sensor
- Discharge pressure sensor
- Tubing pressure sensor
- Casing pressure sensor

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