Sucker Rod
Pump Controller

NOV Monoflo's Sucker Rod Pump Controller (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.

Overview

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 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 NOV Monoflo 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, 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.

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, pump position, and pump load, as well as dynameter plots of surface and downhole conditions.

Sophisticated Modeling

Embedded mathematical models of the drive, motor, pump unit, rod string, pump, flow line, tubing, casing, fluid and reservoir use component specifications and well completion information along with field set up parameters to monitor pumping system operation. Identification routines automatically determine installation dependant 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.

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 charges can also be programmed to occur at selected crank angles or rod positions. Rotaflex cornering speed control automatically calculates breaking 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 at high pumping speeds.

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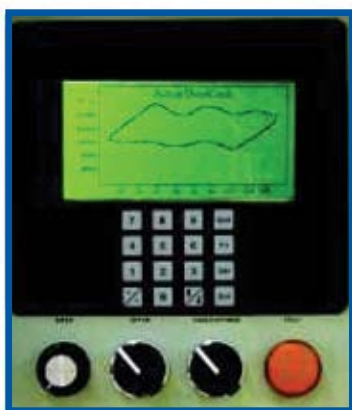
Ease to use controls and simple English descriptions make the controller operator friendly
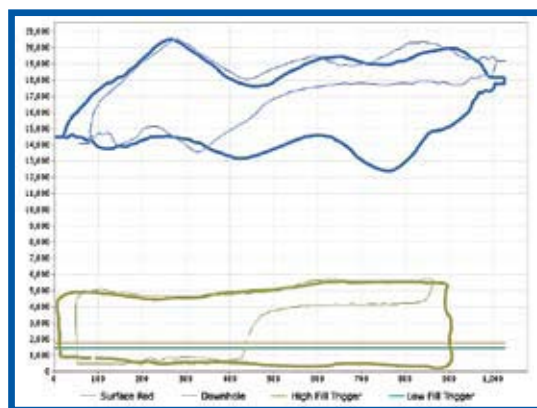
Both surface and downhole dynacards can be viewed on the graphical screen

Features

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 and 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 minimum pump speed can be used to prevent sanding in the well.

Fluid Level Monitor
A fluid level monitor provides a continuous estimate 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 analogue sensors 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.

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 complections, and rod friction is automatically identified. Rod and pump monitors continuously measure and display polished rod and downhole pump load, velocities and positions. Rod force can be measured directly from a load cell or internally computed without the need for an external instrumentation. A rod load limiter automatically adjusts downstroke speed to eliminate rod float by maintaining minimum rod 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.
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Features (continued)

Counterbalance Monitor

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

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 metre 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.

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.

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 resetable production accumulator. Estimated well production is displayed for the operator and is available for remote well monitoring through a communication port.

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 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. User programmable reports can be generated using software that connects system parameters to Excel spreadsheets.

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