ePAC Rod Pumping System

A Weatherford Company

eProduction Solutions' (eP's) ePAC drive is specifically designed for oilfield pumping applications. The ePAC offers performance enhancement beyond that of conventional variable frequency or variable speed drives as it incorporates Flux Vector Drive (VFD) technology for the precision control of both speed and torque. This improved control can aid the optimization of electrically driven artificial lift systems.

The ePAC has a proven track record of performance enhancement with traditional pump jacks and long-stroke pumping units such as the Weatherford Rotaflex. The ongoing development, deployment, and enhancement of VFD technology can result in a higher economic return from the operation of rod pumped wells.

Why use an ePAC?

eP's ePAC drive can be used to improve pump performance and well productivity in most oilfield rod pumping applications. The advanced control algorithm can increase productivity and extend the life of both new and existing artificial lift systems.

The ePAC is able to deliver this functionality by providing precise control of motor voltage, current, speed, and torque. This provides continuous monitoring of operational parameters and allows the ePAC to quickly adapt to dynamic downhole conditions at all speeds.

ePAC can further aid optimization by:

- Automatically adjusting speed to match well inflow performance
- Offering infinite speed control
- Providing independent up/down stroke speeds
- Reducing total rod pumping system power consumption
- Reducing rod parts
- Offering a 20% increase in SPM over conventionally controlled units (Rotaflex)
- Utilizing an integral tracker system that controls bridle separation from the sucker rod

The ePAC overcomes the inefficient production problems found with the traditional control systems used for slow pumping in heavy oil applications. Precise torque and speed control allow the system to operate at all speeds while offering protection to the system.

Cost Saving Features

As a result of more efficient use of electrical power the use of an ePAC drive will significantly reduce the lift cost per barrel of fluid produced to surface as well as reducing maintenance costs for the primary method of artificial lift. The high efficiency operation of the pumping unit can limit the amount of stress placed on the rods during normal operations and as a result of this can significantly reduce the number of repairs required during the life of the rod pumping system.

- Uses high efficiency (92% - 96%) standard motors in place of low efficiency (82% - 86%) high slip motors.
- ePAC drives incorporate unique design features that reduce electric utility costs and improve power quality.
- The drives provide near-unity power factor at all speeds and loads, to avoid utility power factor penalties.
- Gearbox torque limiter protects the gearbox from excessive torque loads, reducing the possibility of gearbox damage.
- Rod force limiter reduces the possibility of rod part.
- Eliminates the high in-rush currents of across the line motor starting.
- Smoothes energy consumption by reducing excessive rod forces and counter balance errors.

- Reduces power consumption
- Minimizes mechanical stress on equipment
- Eliminates excessive rod force
- Uses pump fill algorithms to optimize production
- Maximum torque from 0 to base speed
- Does not require external load cell input
- Adjustable dynamic braking
- Independent up and down stroke speed

Performance Features

The ePAC is designed to operate with 230, 380, 460, or 575 Volt 50/60 Hz power sources. Units are also available for operation from single-phase power lines.

- Minimum fill controller provides simple pump off control of wells with poor inflow characteristics.
- Gearbox ratio monitor automatically computes the overall ratio between the motor and crankshaft with each stroke of the pump.
- Pump speed monitor provides instantaneous and average pump speeds.
- Independent operator-adjustable up and down stroking speed set points.
- Set point speed based on pump fill and feed back from the beam position sensor, that senses the direction of the polished rod.
- Internal limit switch provides adjustable crank angle points for changing pump upstroke, downstroke, and cornering speed on Rotaflex jack pumps.
- Integral tracker system controls separation of the bridle from the sucker rod.
- Pump fill optimizer maximizes well production and eliminates fluid pound by independently adjusting up and down stroke speeds.
- Heavy-gauge Nema 3R enclosures seal the ePAC electronics from environmental factors such as sand, moisture, and small organisms.
- Optional graphic display for viewing real-time surface and pump cards.

Operational Modes

Single Speed

In single speed mode, the user sets one speed for the up and down stroke. The pump speed monitor uses the motor velocity and overall gear ratio to calculate both the instantaneous and average pump speed.

Dual Speed

Dual speed control mode allows the operator to manually optimize the performance of the well by adjusting both the up and down stroke speeds to the required speeds.

Optimize

The pump fill optimizer offers an advanced form of pump fill control without the traditional requirement of separate devices or control hardware.

The ePAC automatically adapts to changing well inflow characteristics by adjusting up and down stroke speeds to maximize well production while avoiding fluid pound.

The pump fill monitor uses information from the motor and crank to determine pump fill percentage. Pump fill is displayed to the operator as a percent fill number and is used to automatically optimize well production.

Automatic Control

The ePAC's embedded programming allows the user to preset limits to customize the control to the application.

These controls are active in all operational modes and include:

- Minimum and maximum SPM
- Gear ratio monitor automatically computes the overall gear ratio between the motor and the crankshaft each stroke of the pump and is used to monitor belt slip. Gearbox torque limits can be preset to limit gearbox stress.
- Rod force limiter reduces rod breaks by limiting the maximum stress that can be placed on the rods and as such increases rod life by reducing fatigue. It also can reduce rod compression damage by controlling the minimum rod force. Maximum and minimum rod forces, and associated rod positions, are captured with each stroke of the pump, and the rod force is adjusted automatically to stay within preset parameters.
- Bridle separation controller uses an internal calculation to detect loss of rod weight on the pump downstroke due to rod float. The separation limiter automatically adjusts downstroke speed to track rod float while maximizing production.
- Pump jack imbalance is displayed to the operator as positive (overbalanced) or negative (underbalanced) crankshaft torque. Imbalance information allows the operator to easily position or change the counterweights to minimize gearbox stress and energy consumption.
- The pump flow monitor uses well parameters and drive information to estimate pump flow. The estimated well production is displayed to the operator in BPD.

Control Monitoring

UEDIT software allows the system to be monitored through one of the ePAC's serial ports. Various screens provide configuration and operational interfaces, including:

- The dynagraph screen can be used to display both surface and pump card.
- Data in the ePAC can be uploaded to an archive as a backup or downloaded to the drive from the archive to restore prior setup information.

User Interfaces

- An operator interface provides access to system parameters that are organized into logical groupings for easy navigation.
- On-line setup instructions, prompts, warnings, bar graph displays, and logical data groupings result in fast startups, smooth operation, and minimum downtime.
- Pump fill monitor continuously measures and displays the pump fill percentage.
- 16-button keypad allows simple menu navigation and data entry.
- 2-line by 24-character display provides easily read text/graphics.
- Optional graphics display available for viewing real-time surface and pump cards.
- Password protection is used to prevent unauthorized access to drive parameters.
- Fault log is used to capture time-stamped diagnostic information to aid in troubleshooting drive or pump problems.
- Additional parameters that can be monitored include:
  - Input power monitor
  - Lift power monitor
  - Input power meter
  - Pumping efficiency
  - Production monitor
  - Pump cycle monitor
  - Balance monitor
- Enhanced RTU protocol allows efficient transfer of both 16- and 32-bit data through local or remote networks.

Programmable Logic Controller

UEDIT also incorporates a Programmable Logic Controller (PLC) that can be used to monitor drive operation, customize the drive to unique system needs, and provide a simple migration path for future upgrades.

- Ladder Diagram Screen ~ Logic type signals can be programmed and monitored in familiar ladder diagram formats.
- Function Block Screen ~ Analog type signals can be manipulated and monitored using a rich variety of function blocks.
- Input/Output Screen ~ Input and output signals can be forced and monitored using a convenient I/O display panel.

Specifications

Input Voltage	230, 380, 460, or 575 Vac (±10%)
Supply Frequency	47 to 63 Hz
Power Factor	1.00 displacement power factor; 0.94 overall power factor at all speeds
Operating Temperature	-40° to 122°F (-40° to 50°C)
Storage Temperature	5° to 158°F (-15° to 70°C)
Relative Humidity	5% to 95%, noncondensing
Altitude	0 to 3,300 ft. (1,000 m) at full rating
Analog Inputs	Three 12 bit (±10 Vdc or 4 to 20 mA)
Analog Outputs	Two 12 bit (±10 Vdc and 4 to 20 mA)
Digital Inputs	Twelve (requires sink of mA to common)
Digital Outputs	Six (open-collector drivers rated 24 Vdc @ 500 mA)
Serial Communications	EIA RS-232 and RS-422/485, isolated, 0.3 to 19.2 kbaud
	ANSI-x3.28-2.5-A4, Allen-Bradley DF1, and Modicon RTU protocols

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