Linear Rod Pumping (LRP) Unit

Direct Drive
The LRP system takes advantage of the motor reversing and servo-positioning capabilities of a flux vector variable-speed drive to directly control the sucker rod using a simple rack-and-pinion mechanism. Electronic control provides numerous benefits by eliminating the cumbersome, high-inertia mechanics of other systems.

Simple Design
The LRP pumping unit mounts directly to the wellhead. The polished rod runs through a channel inside the rack and is suspended from the top by a conventional rod clamp. The rod is allowed to float inside the rack should the pump or rod stick. An induction motor, coupled to the rack-and-pinion mechanism through a gearbox, cycles the rack up and down to reciprocate the rod. The rack is lubricated at each stroke by submersion into a fully contained oil bath. A pneumatic counterbalance on air-balanced units replaces the massive counterweight of conventional systems and provides greater lifting force by storing energy during a portion of each downstroke and releasing it during the subsequent upstroke.

Easy to Install
The LRP unit is small, lightweight and easy to transport. No specialized or heavy equipment is required, saving on installation costs. It can be carried in a light-duty truck and installed with a 1-ton rig or small picker. Installation is quick and easy and can be handled by two people. Units can be installed and fully operational within a couple of hours.

Environmentally Friendly
The LRP system is the ideal choice for environmentally sensitive installations. It is quiet, unobtrusive and does not require site grading, mounting pads, or other well site disruptions. Its low profile and small footprint allow it to blend in where other units may be prohibited by regulation.

Portable
Since it is easy to transport and commission, the LRP system can easily be moved from well to well for temporary installations or to prove reserves efficient. The low-inertia design of the LRP system allows it to use a much smaller motor and gearbox than a conventional unit to provide the necessary capability. Programmable motion profiles give the LRP system the effective stroke of a much larger unit. Therefore, a much smaller LRP unit will provide the same or better production at a lower cost.

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Rod Stroke (in)</th>
<th>Rod Force (lb)</th>
<th>Rod Speed (fpm)</th>
<th>Pump Speed (fpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L073g-mmmm-020</td>
<td>20</td>
<td>4000</td>
<td>10-250</td>
<td>0.5-25.0</td>
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<tr>
<td>L073g-mmmm-032</td>
<td>32</td>
<td>4000</td>
<td>10-250</td>
<td>0.5-25.0</td>
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<td>L137g-mmmm-032</td>
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<td>L239g-mmmm-032</td>
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<td>L381g-mmmm-044</td>
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<td>0.5-21.4</td>
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<td>L381g-mmmm-086</td>
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<tr>
<td>L826g-mmmm-086</td>
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<td>10-375</td>
<td>0.5-21.0</td>
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<td>10-375</td>
<td>0.5-18.0</td>
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<td>0.5-15.0</td>
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<tr>
<td>L826g-mmmm-144</td>
<td>144</td>
<td>30,000</td>
<td>10-375</td>
<td>0.5-12.5</td>
</tr>
</tbody>
</table>

By combining a few different rack lengths, gearboxes (g), motors (mmm) and drives, the LRP system provides maximum application flexibility with minimal spare parts.
General Control Features

Pump Fill Control Speed is automatically controlled to maintain target pump fill

Pump-Off Control Pump shuts off for a select time if unable to maintain target fill at minimum speed

Soft Landing Using real-time downhole dynamometer feedback, pump slows down prior to fluid impact anytime pump fill drops below the maximum setting

Bridle Control Pump speed is reduced if rod separates from rack, eliminating violence during reconnection

- First LRP installed in December 2006
  - First prototype units ran 45 days
  - Rented pick-up used to replace prototypes

- Over 150 LRP systems installed or pending installation
  - 25 oil and gas producers installing LRP technology
  - Well depths from 50 to 6400 feet
  - Production rates from 5 to 300 bpd
  - Peak rod loads up to 18,000 pounds
  - Over 100,000,000 cumulative pump strokes

- Speed Controlled Modes of Operation
  - Single Speed
    - Same upstroke and downstroke speed from a single speed source
  - Dual Speed
    - Different upstroke and downstroke speeds from separate speed sources
  - Optimized Speed
    - Controller chooses optimal speed, including reduced speed soft landing prior to fluid impact
  - Speed Limiters
    - Upstroke minimum and maximum spm
    - Downstroke minimum and maximum spm
  - Variable Pump Stroke
    - Ability to “tag” if operator requests
  - Wide Speed Range Operation
    - 2 spm to 20 spm
  - Pump Fill Control
    - Speed is automatically controlled to maintain target pump fill
  - Pump-Off Control
    - Pump shuts off for a select time if unable to maintain target fill at minimum speed
  - Soft Landing
    - Using real-time downhole dynamometer feedback, pump slows down prior to fluid impact anytime pump fill drops below the maximum setting
  - Bridle Control
    - Pump speed is reduced if rod separates from rack, eliminating violence during reconnection