



The Science of PECL™

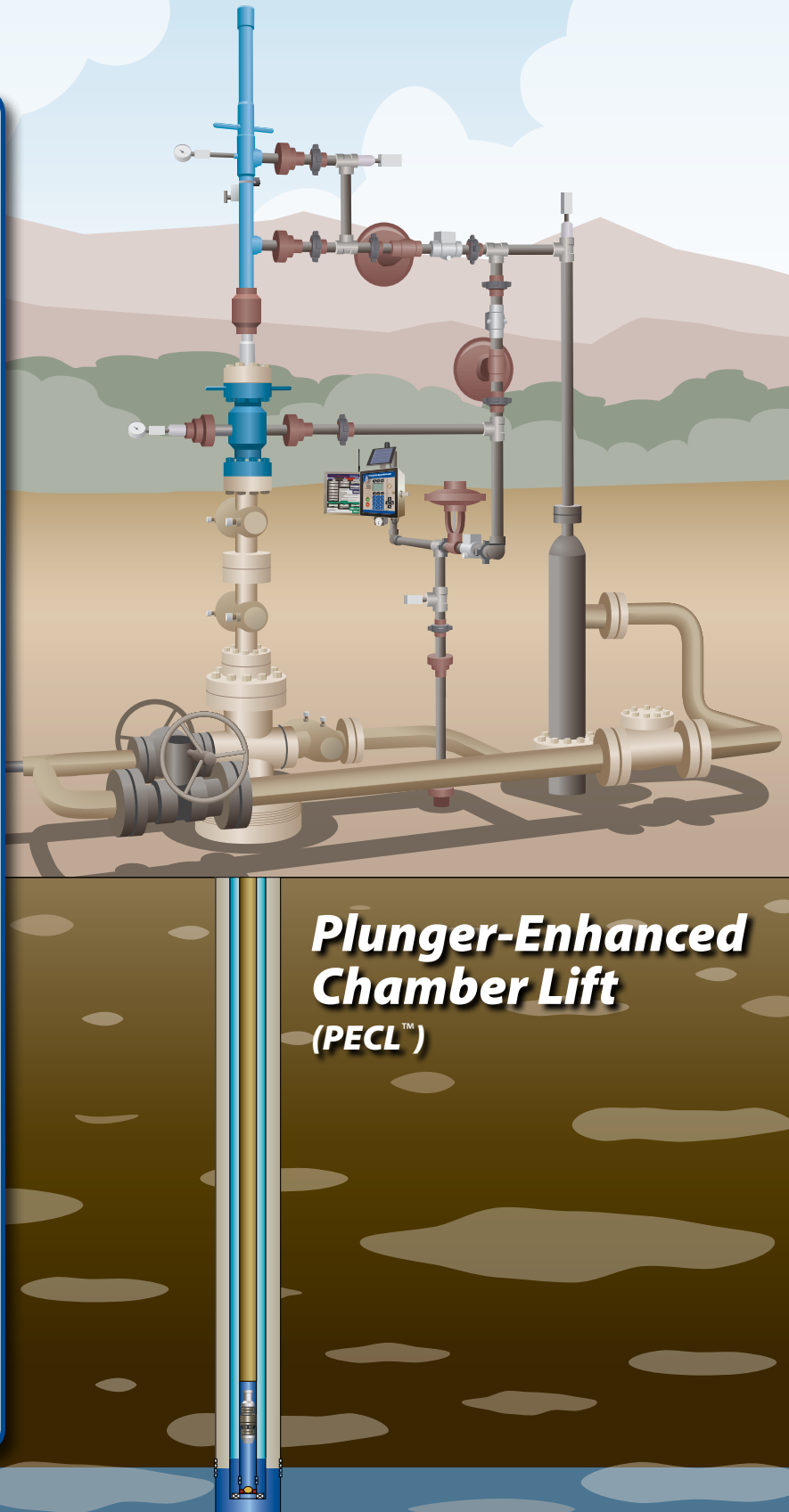
Combining Plunger and Chamber Lift Technologies

When the gas flow rate reaches or drops below critical velocity, wells cease to operate efficiently as the produced liquids can no longer be effectively removed from the wellbore. In an effort to remove the liquids and return the well to an improved producing state, operators may apply an artificial lift method referred to as “Gas Lift.” With this method, high-pressure gas is injected into the annulus of the well bore. Through a series of valves in the tubing string, liquid is lifted to the surface, and as a result, the gas flow rate is increased above critical velocity.

“Chamber Lift” is a form of gas lift. Chamber lift can be used in conjunction with long perforated interval reservoirs. In addition, low-pressure reservoirs can benefit from this type of lift. Gas is injected into the annulus and displaces the fluid in the chamber into the production tubing. This process is “intermittent and cyclical” and has a high volume of gas-slippage through the fluid slug. As a result – “liquid fallback” occurs down the tubing and is neither removed from the wellbore nor produced at the surface. Liquid fallback is 5% per 1,000 feet of vertical lift for chamber lift systems.

With PECL™, a “Plunger” is added to Chamber Lift to improve the efficiency of liquid removal. Liquid fallback, from the intermittent cycle is significantly reduced. The plunger creates a solid interface between the liquid slug (above the plunger) and gas energy (below the plunger) – effectively sweeping the tubing clean on ascent to the surface of the well.

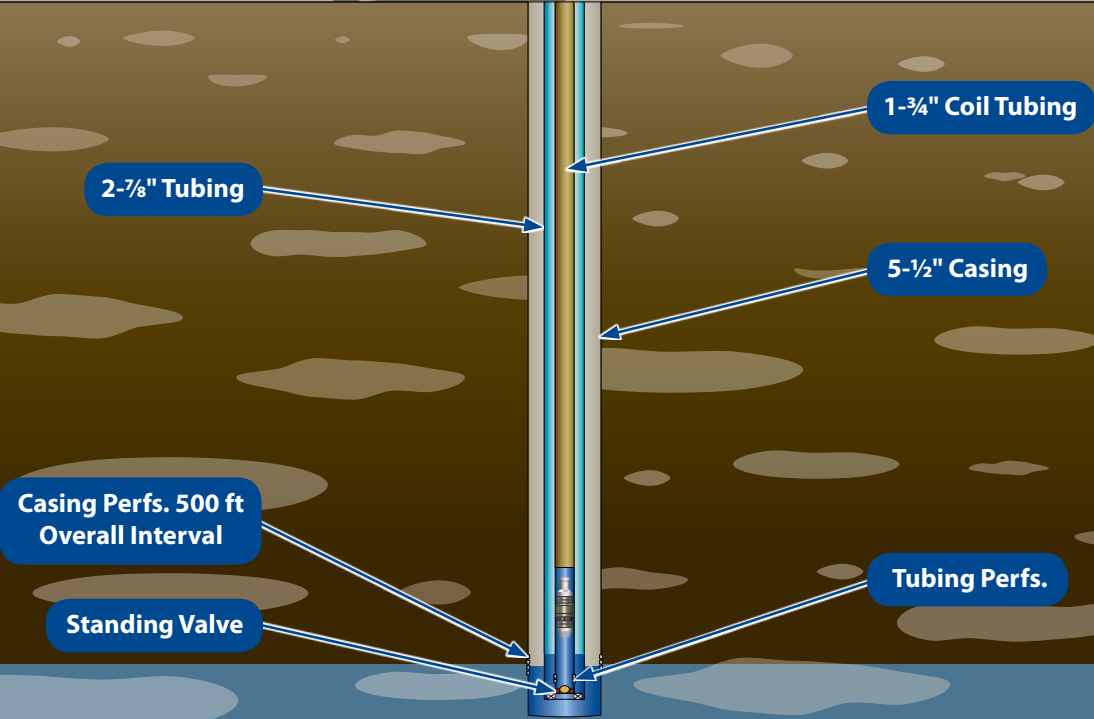
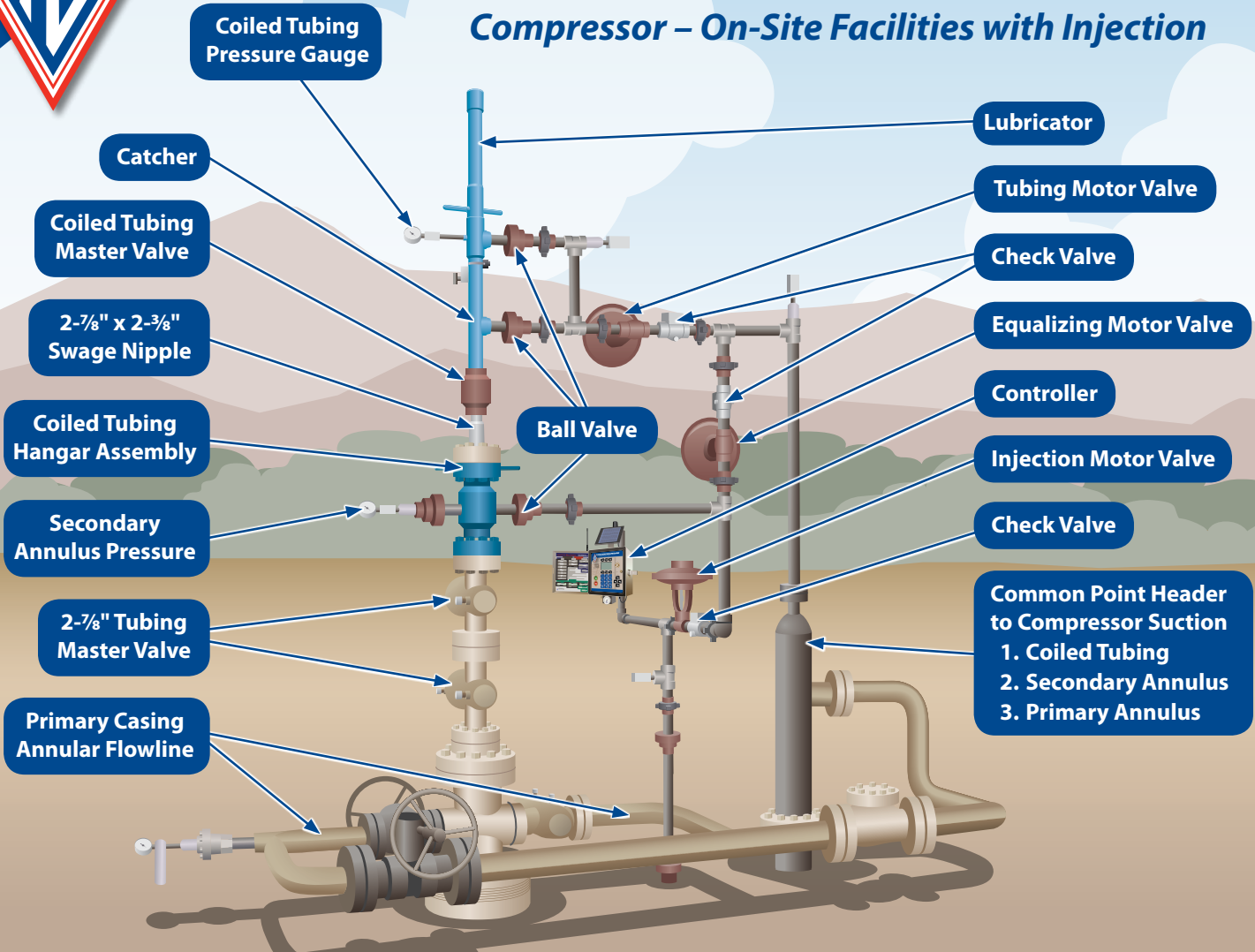
Combining the technologies of intermittent plunger lift and chamber lift significantly improves the operating economics for well operations. Surface motor valves allow for redeploying the discharge gas (from a compressor) and utilizing this as the prime mover energy source for the plunger, further enhancing the system’s overall operating performance. Well inflow is maximized. Production is improved. Energy management is completely utilized. All with low operating expenses.

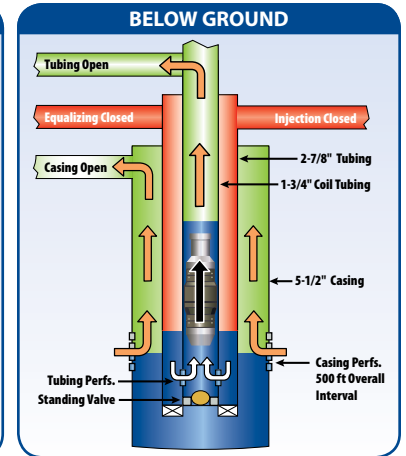
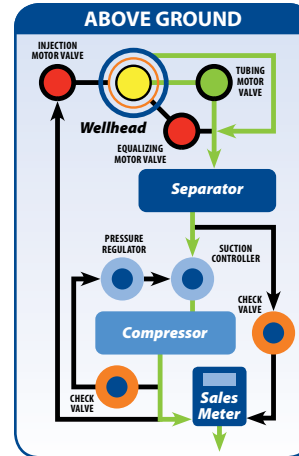
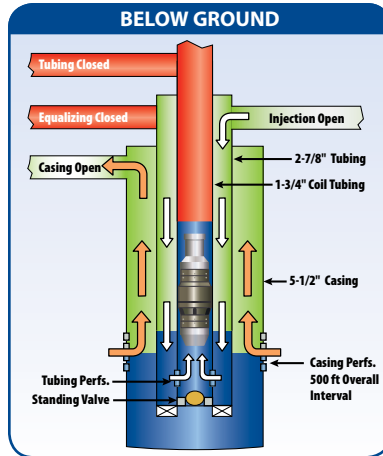
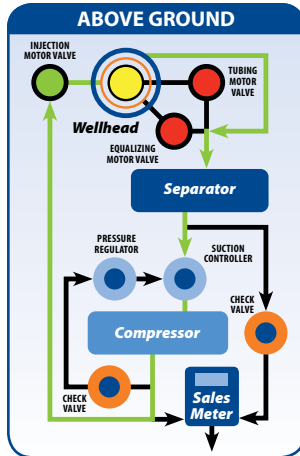


Plunger-Enhanced Chamber Lift (PECL™)



Compressor – On-Site Facilities with Injection





Step 1: PRE-CHARGE CYCLE

Aboveground Wellhead Operation:

1. Source gas from the annulus is delivered via a compressor to the separation facility and injected into the TBG/TBG annulus.
2. Tubing Motor Valve and Equalizing Motor Valve are **closed**.
3. Injection Motor Valve is **open** (see downhole process below - Item 3 – for completion of operation).
4. This function increases the pressure on the TBG/TBG annulus forcing fluid into the production tubing via the perforated nipple on bottom of the production tubing string.

Downhole Operation:

1. Gas is removed from the primary annulus and injected into the secondary annulus (between the concentric and tubing strings).
2. Some fluid is transferred from the secondary annulus to the coiled tubing during this operation (the Tubing Motor Valve is **closed** during this process)
3. The Injection Motor Valve is **closed** after this step is completed.
4. Injection pressure is not seen at the perforations and is isolated by the standing valve assembly on bottom of tubing.

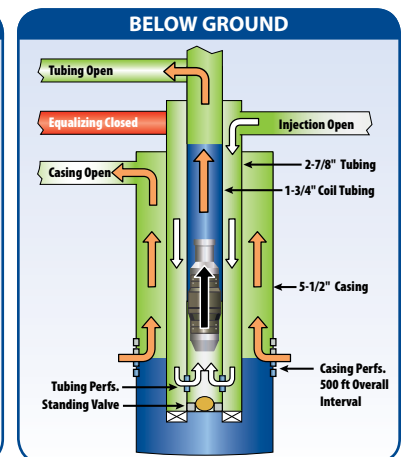
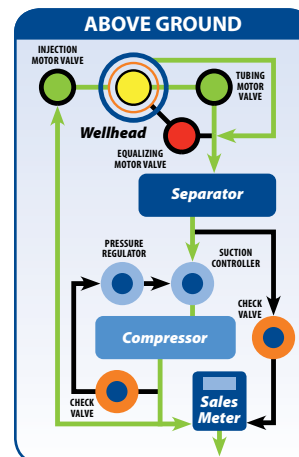
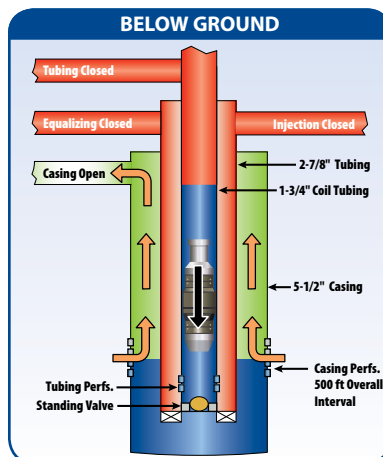
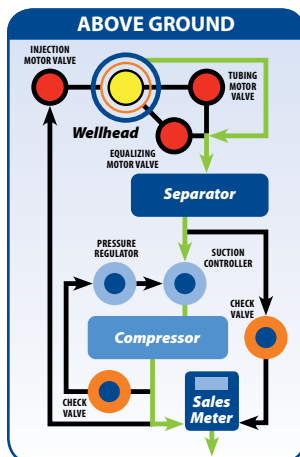
Step 2: PURGE "ON" CYCLE

Aboveground Wellhead Operation:

1. Source gas from the annulus is delivered via a compressor to the separation facility and sold through the Sales Meter.
2. Injection Motor Valve and Equalizing Motor Valve are **closed**.

Downhole Operation:

1. Tubing Motor Valve is **open** (which starts the plunger and liquid slug to ascend).
 - This function ensures that the liquid is displaced from the TBG/TBG annulus and into the production tubing.
 - Required time for operation to occur: 30 seconds to 1 minute
2. Injection pressure is not seen at the perforations and is isolated by the standing valve assembly on bottom of tubing.
3. The Tubing Motor Valve is **closed** after this step is completed.



Step 3: PURGE "OFF" CYCLE

Aboveground Wellhead Operation:

1. Source gas from the annulus is delivered via compressor to the separation facility and sold through the Sales Meter.
2. Injection Motor Valve, Equalizing Motor Valve and Tubing Motor Valve are each **closed**.

Downhole Operation:

1. Since Tubing Motor Valve is **closed** - the plunger descends back to the bottom of the tubing stop, repositioning under the entire liquid slug.
 - Average amount of time required for plunger to return to bottom: 5 min.
2. Injection pressure is not seen at the perforations and is isolated by the standing valve assembly on bottom of tubing.

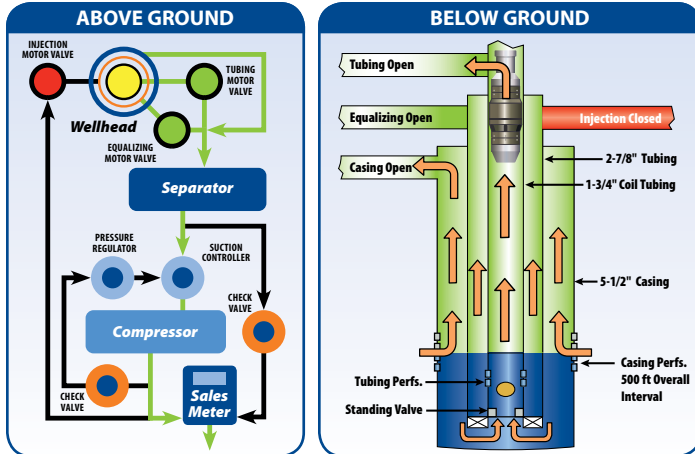
Step 4: ON CYCLE

Aboveground Wellhead Operation:

1. Source gas from the annulus is delivered via a compressor to the separation facility and injected into the TBG/TBG annulus.
2. Equalizing Motor Valve is **closed**.
3. Tubing Motor Valve is **opened** concurrently with the Injection Motor Valve.

Downhole Operation:

1. The plunger is lifted to the surface – removing the fluid slug from the tubing .
2. Injection pressure is not seen at the perforations and is isolated by the standing valve assembly on bottom of tubing.



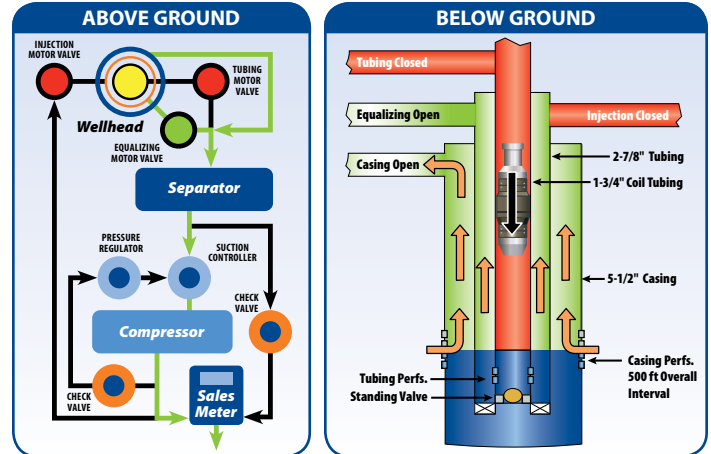
Step 5: AFTER FLOW CYCLE

Aboveground Wellhead Operation:

1. Source gas from all strings is delivered to the separation facility via compression and sold through the Sales Meter.
2. The Plunger is detected at the surface – the Injection Motor Valve switches to **closed**.
3. Tubing Motor Valve and Equalizing Motor Valve are **open**.
4. This function allows the secondary annulus to equalize with all tubing and casing strings to allow fluid entry into the well bore (contained to lowest possible height during this operation).

Downhole Operation:

1. Fluid is displaced across the largest cross-sectional area, thus minimizing the liquid head pressure.



Step 6: OFF CYCLE

Aboveground Wellhead Operation:

1. Source gas from the annulus is delivered via a compressor to the separation facility and injected into the TBG/TBG annulus.
2. Tubing Motor Valve is **closed**.
 - The Plunger is returned to the bottom of the tubing string
3. Injection Motor Valve is **closed**.
4. Equalizing Motor Valve is **open**.

Downhole Operation:

1. The plunger descends to the bottom of the tubing string
 - The secondary annulus is continually open during this period allowing fluid entry and equalization of the surface pressure with the casing
 - **RETURN TO STEP 1 – REPEAT THE PROCESS**
 - The primary casing is open 24 hours per day – therefore, permitting continuous flow through the path of least resistance, minimizing flowing bottom hole pressure

*For more information,
contact your local field technician,
or call our main office:*

1-800-282-0039