Liquid Loading

Dave Barry

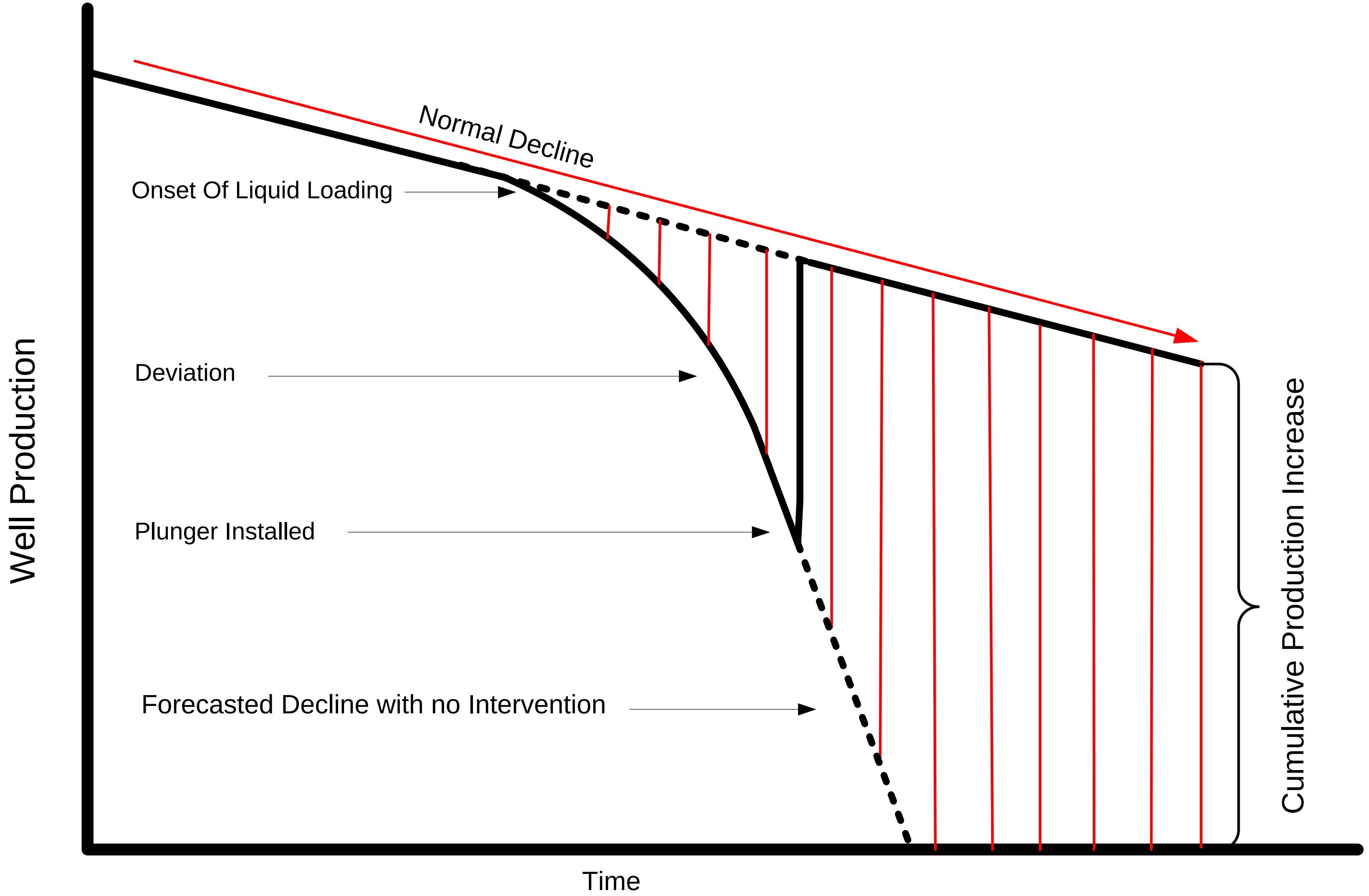
Liquid Loading

- All gas wells, at some time during there producing life, will experience liquid loading problems
- Once Flowrate drops below a certain rate, the well will begin to load up
- The amount of liquid produced does influence how quickly the subsequent loading up process takes

Critical Velocity

- Gas velocity (Flowrate) in the tubing has drops below the minimum required to move liquids up and out of the wellbore.
- Liquids are settle in the bottom of the well tubing.
- Gas flows in heads (slug flow) or bubble flow (gas bubbles through liquids).
- Loads up during natural flow.

Typical Production Decline Curve



Typical Gas Well Production Decline

Popular Remedies

Surface

- Venting (Environmental Issues)
- Intermitting (Good 1st Step, but limited time usage)
- Soaping (Messy and Expensive)
- Chemical Injection (Expensive)
- Gas Lift (Works, but have to buy back gas to inject)
- Compression (Maintenance & Expensive)

Subsurface

- Velocity Tubing Stings (Requires Workover)
- Pumping Unit (Expensive to Operate)
- Electric Submersible Pumps (Expensive to install, expensive to work on, expensive to operate)
- Plunger Lift (Lowest Cost to Install, easy to operate, low recurring costs)

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Comparing Remedies

- **Criteria**
  - **Lowest flowing bottom hole pressure desired**
    - **Equals Lowest casing pressure**
  - **Mechanical limitations**
    - **Limit Choices**
  - **Cost Analysis**
    - **Choice has to make economic sense**
    - **Have to make more money, not just more oil/gas**
  - **Operator Capabilities**
    - **Operators can do what they are trained to do**
    - **Must learn required skills**

What is Plunger Lift

- Technique used to optimize gas production.
- Steel plunger is inserted into the production tubing.
- Well shut-in causes plunger to fall allowing fluid to collect above plunger.
- Different techniques are used to decide how long to shut in and flow the well.
- Downhole pressure is used to lift the plunger and fluid to surface.
- Goal is to increase gas production by keeping liquid off formation.
- Generally speaking these wells don’t have enough constant downhole pressure to free flow into a gathering system.

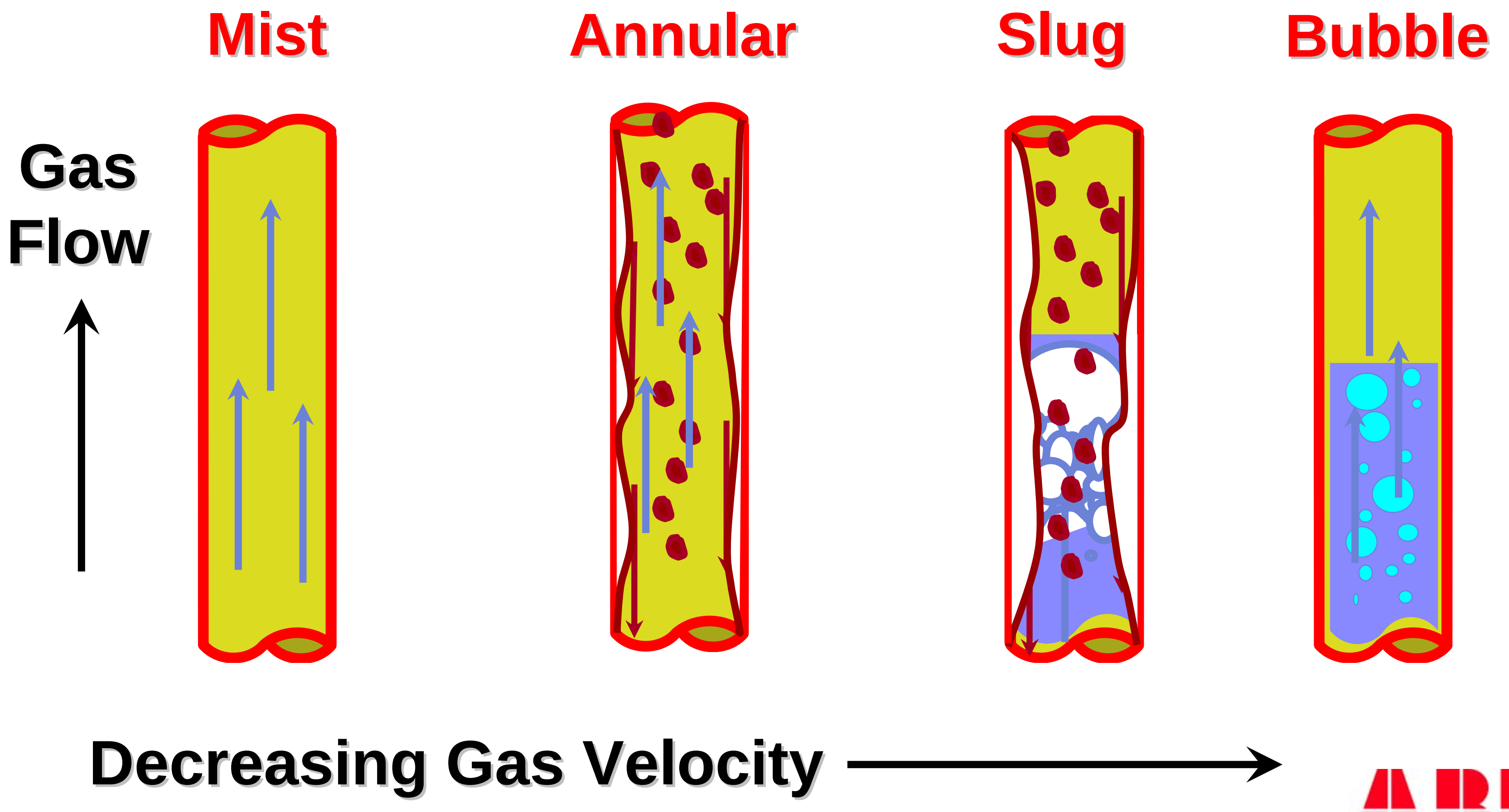
Candidate Selection: Is Plunger Lift Appropriate?

- **Does the Gas to Liquid Ratio meet the minimum requirements?**
  - **400 scf per bbl per 1000' of lift depth**

- **Does the shut in pressures meet minimum requirements?**
  - **Load Ratio <= 0.5** **[Load Ratio = (CP – TP) / (CP – LP)**

  - **Rule of thumb:**
    Max line psi X 1.5 = minimum shut in psi required.

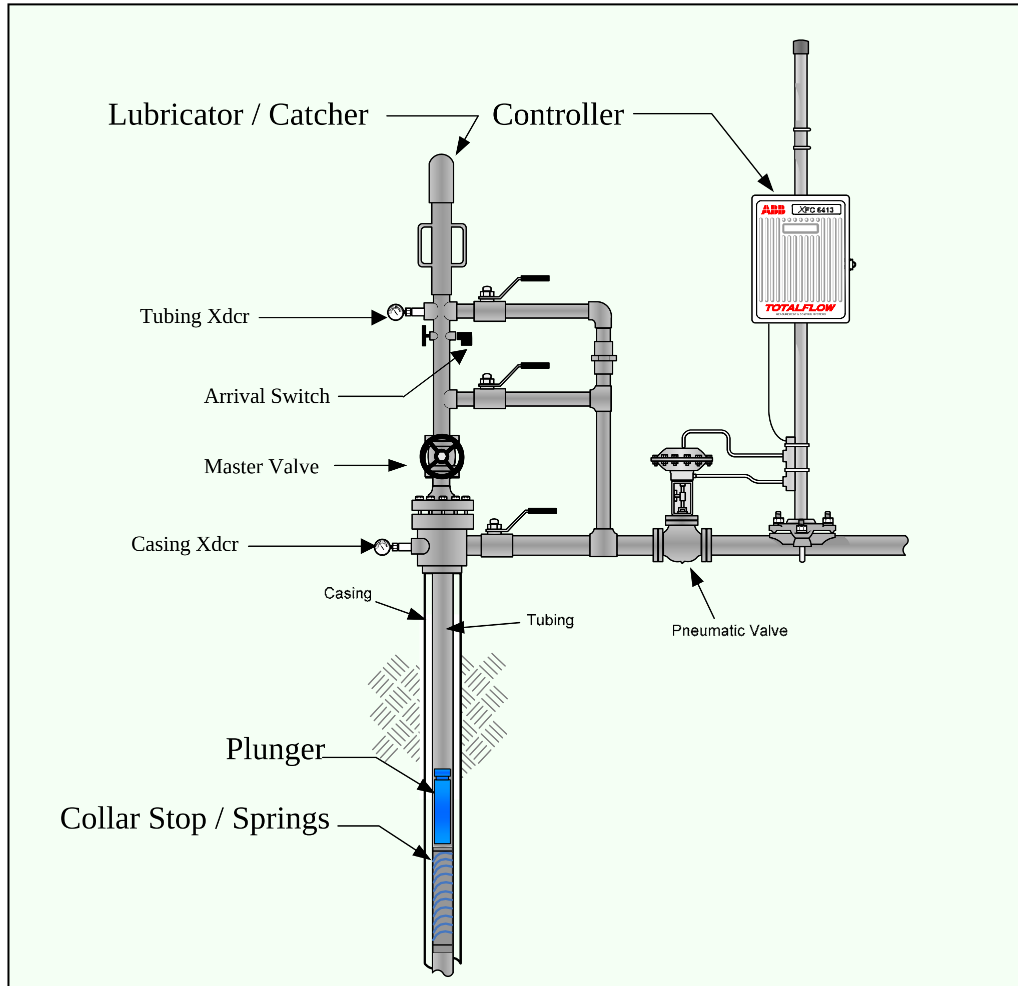
Gas Well Life Cycle: Plunger Lift



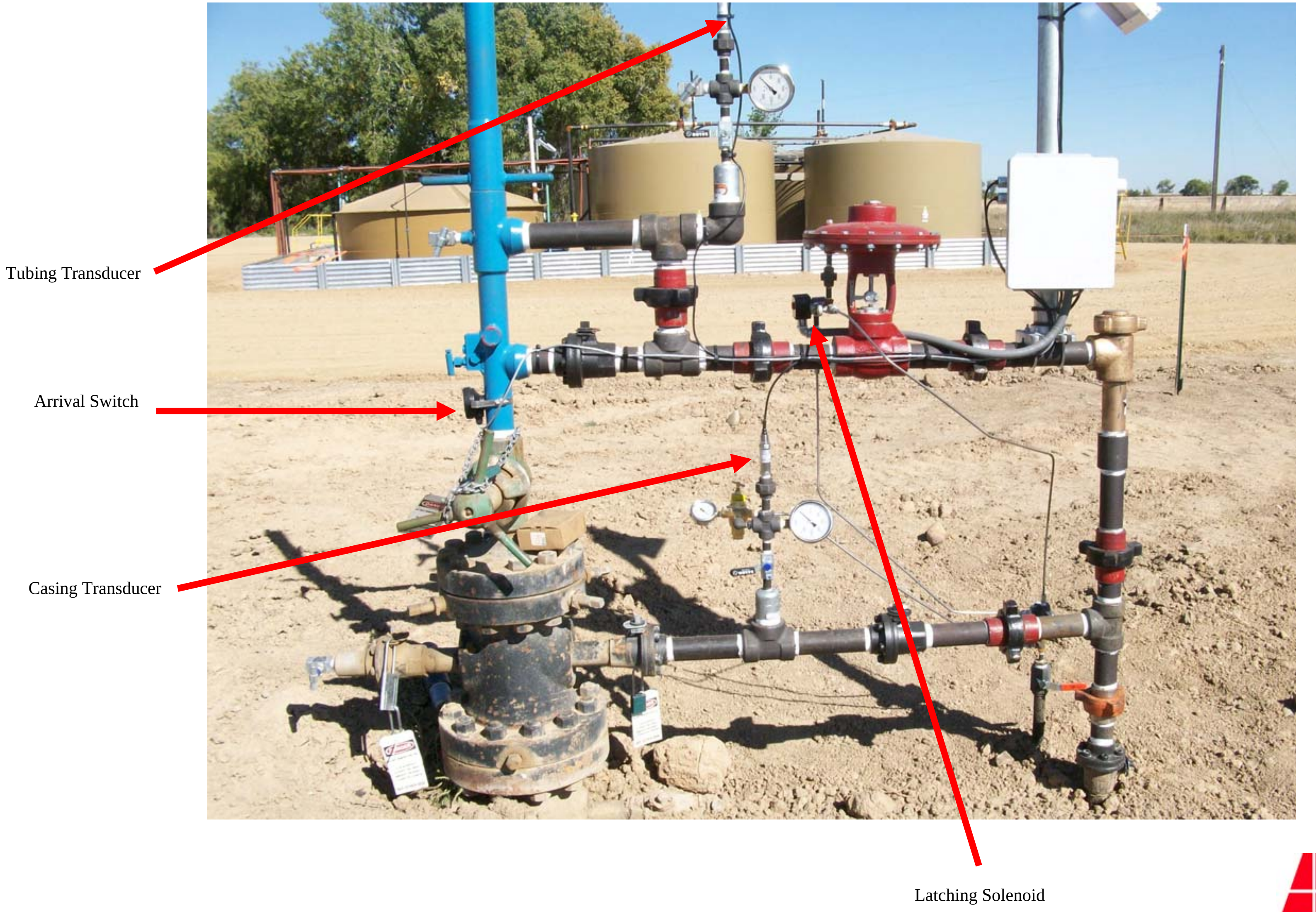
Typical Plunger Lift Wellhead Setup

A typical system consists of:

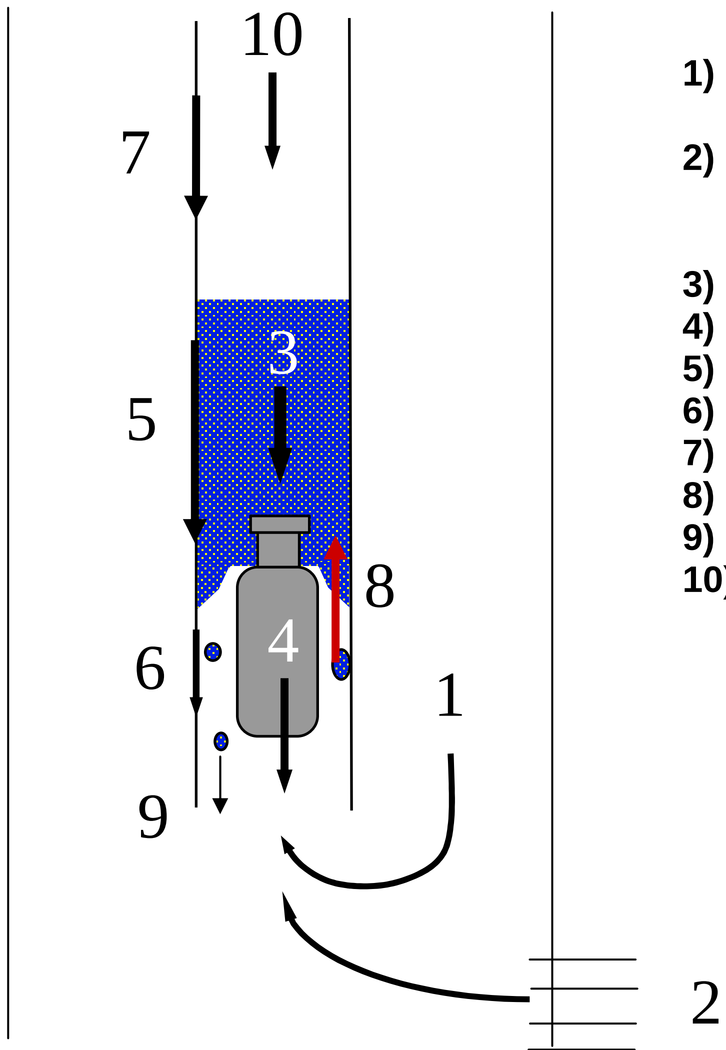
- Collar Stop & Spring
- Plunger
- Lubricator / Catcher
- Controller



Typical Wellhead Hardware Detail



Plunger Force Balance



1) Stored casing pressure freely acting on the cross-section of the plunger
2) Stored reservoir pressure acting on the cross-section of the plunger, based on inflow performance
3) Weight of the liquid above the plunger
4) Weight of the plunger
5) Friction of the fluid with the tubing
6) Friction of the plunger with the tubing
7) Gas friction in the tubing
8) Gas slippage upward past the plunger
9) Liquid slippage downward past the plunger
10) Surface pressure (line pressure and restrictions) acting against the plunger travel

***Pad Plungers** have interlocking stainless steel pads to create a superior seal. The spring-loaded pads are always expanded yet have enough flex to allow the plunger to fall through minor tubing anomalies.*

Plunger Products

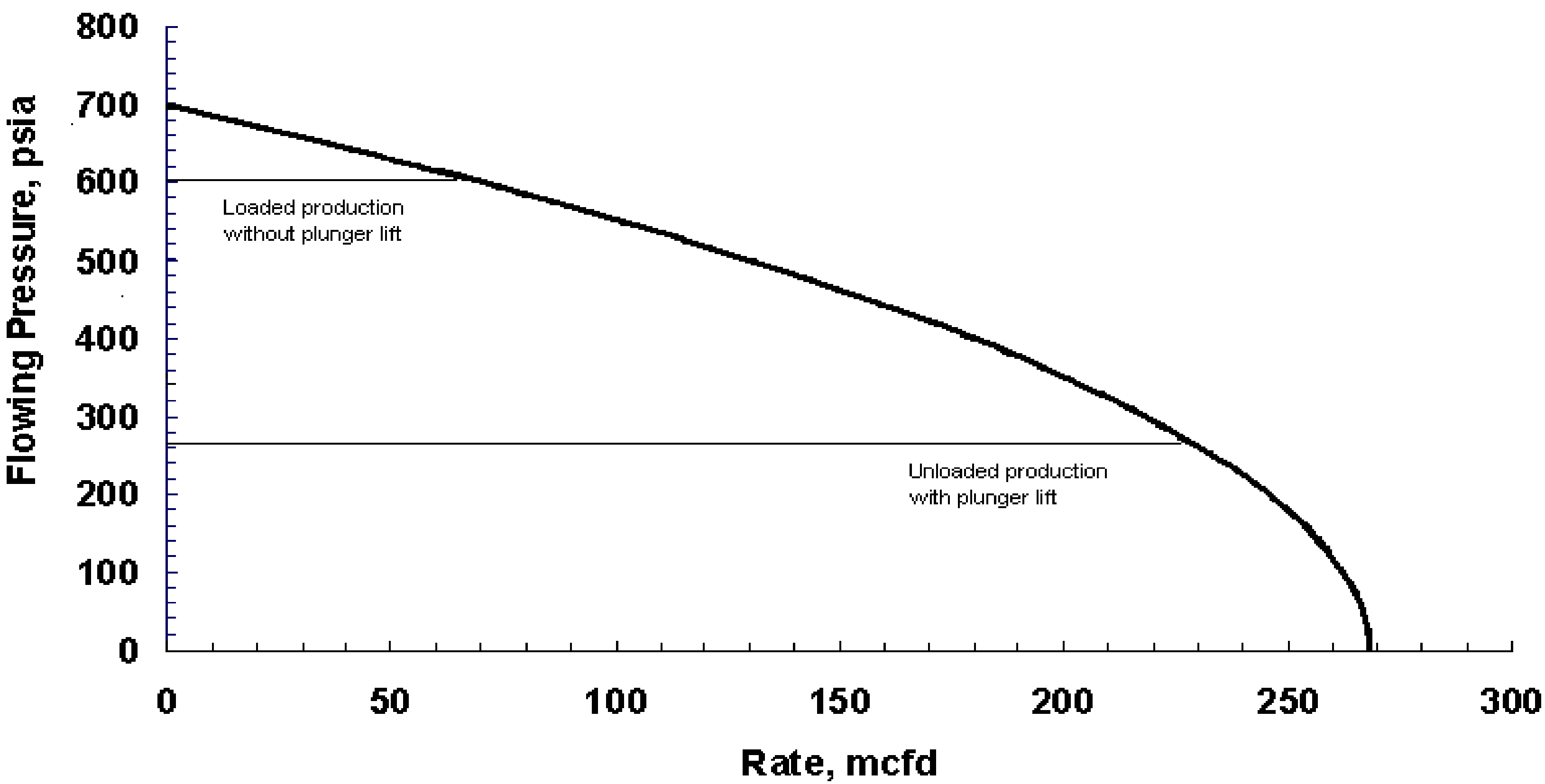
Fiber plungers, ***with its nylon sealing element, is used in weaker wells and sand producing wells. No moving parts makes it the ideal plunger where sand is present.***

Down Hole Products

Down hole springs and stops are engineered and manufactured in a variety of configurations.

Inflow Performance Analysis for Plunger Lift

Example of using inflow performance analysis to estimate plunger lift performance. Chart shows production increase resulting from reducing liquid hydrostatic pressure with a plunger lift system.



Inflow Performance Relationship

- **Optimum Performance**
  - **Cycle Frequency equals smallest liquid loads**
  - **Smallest liquid load equals lowest BHP requirements**
  - **Lowest operating BHP equals best inflow performace**

Most Cycles	**Smallest Liquid Loads**	**Lowest BHP Requirements**	**Best Inflow Performance $$$$$$**

Plunger Lift vs. Gas Production Theory

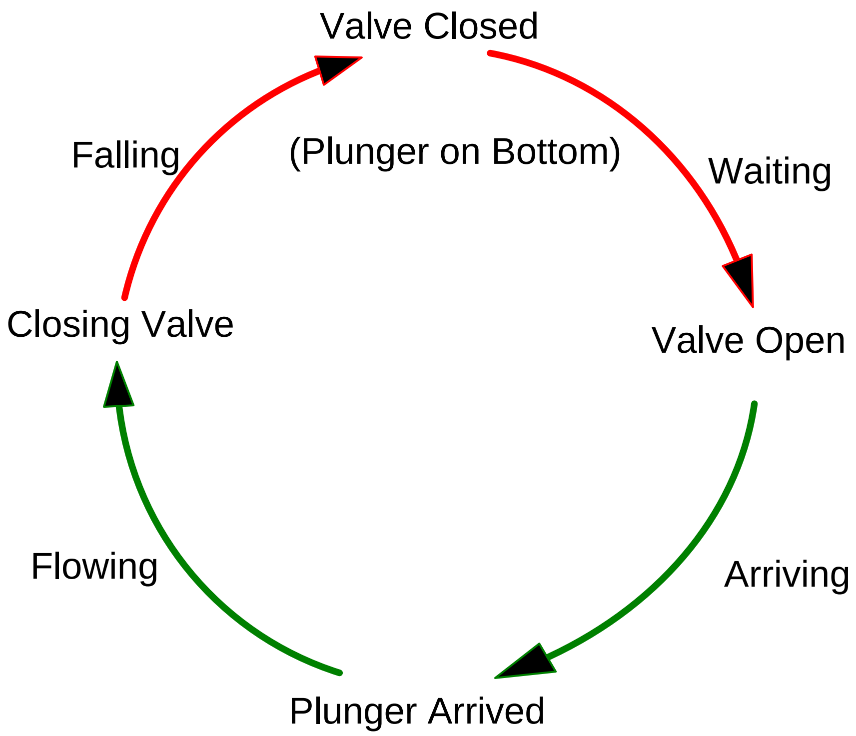
- The producing tendency of plunger lift is directly opposed to that of the well.
- Plunger lift requires an increase in casing pressure for increased production.
- The well requires a decrease in casing pressure for increased production.
- The compromise that always yields the greatest production is found when cycling the plunger at the maximum frequency possible without killing the well.

Jim Hacksma (Consultant)

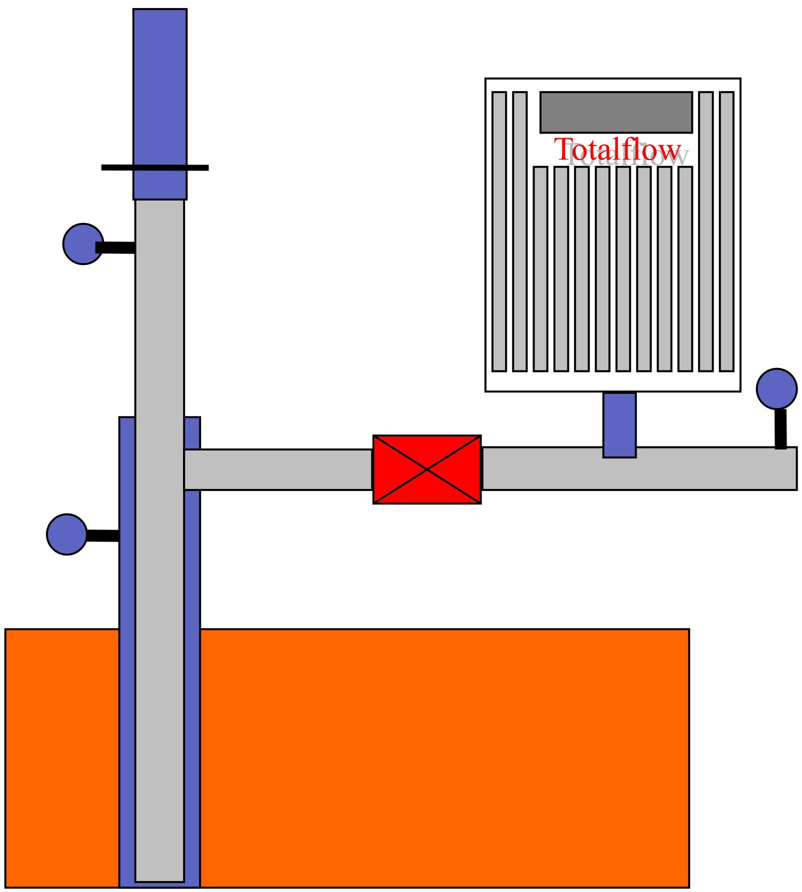
1972, User’s Guide to Plunger Lift Performance

Plunger Lift States

- Closing Valve
  - Falling
- Valve Closed
  - Waiting
- Valve Open
  - Arriving
- Plunger Arrived
  - Flowing



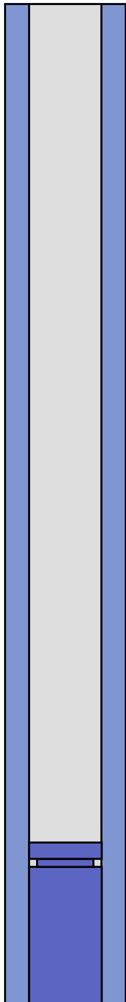
Valve Closed (State 2)



1) Timer
2) Tubing - Line
3) Casing - Line
4) Casing - Line & Tubing - Line
5) Casing - Tubing
6) Casing – Tubing & Tubing - Line
7) Load Ratio
8) Tubing Pressure
9) Casing Pressure
10) Static Pressure
11) Slug Size
12) Optional Input (2)

Plunger Arriving (State 3)

Arrival Times



Maximum

Close ‘A’ Valve or Open ‘B’ Valve

Tune for faster next cycle

Slow

Don’t tune
(ascension velocity is correct)

Fast

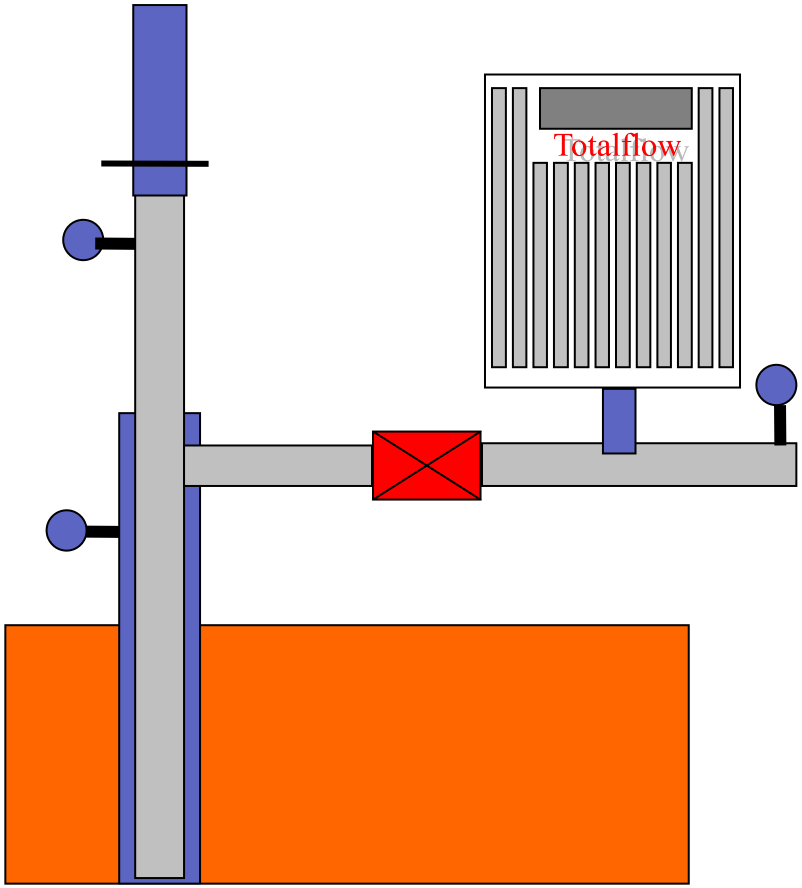
Tune for slower next cycle

Minimum

Don’t tune
(plunger may not have reached bottom)

Recommended Ascension Velocity:
750 – 1,000 ft/min

Afterflow (State 6)



1) Timer
2) Turner
3) Load Ratio
4) Differential Pressure
5) Flowrate
6) Tubing - Line
7) Casing - Tubing
8) Tubing Pressure
9) Casing Pressure
10) Static Pressure
11) Slug Size
12) Optional Input (2)

Foaming

- Works best on wells with >= 50% Water
- Reduces surface tension
- Reduce the density of the liquid droplets
- Therefore reduces the required Critical Velocity

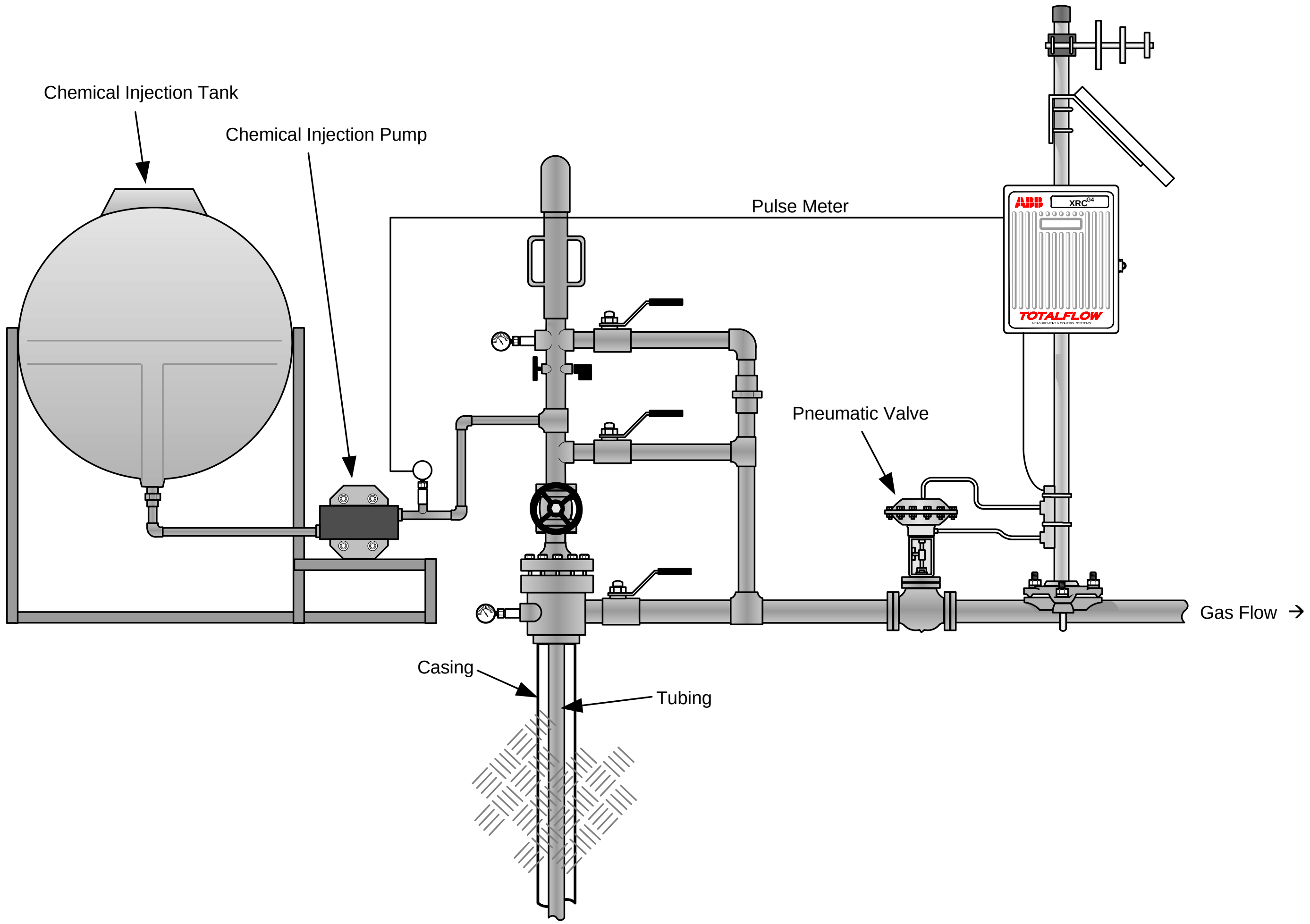
- **Advantages**

1. Simple & inexpensive option for low rate wells. Proportional to liquid water rate.
2. No downhole equipment required. Works best with a capillary tube.
3. Gas velocities of 100 to 1,000 fpm.

- **Disadvantages**

1. Foam carryover or liquid emulsion problems.
2. Effectiveness depends on type amount of well fluids. Wells producing >50% condensate may not foam.

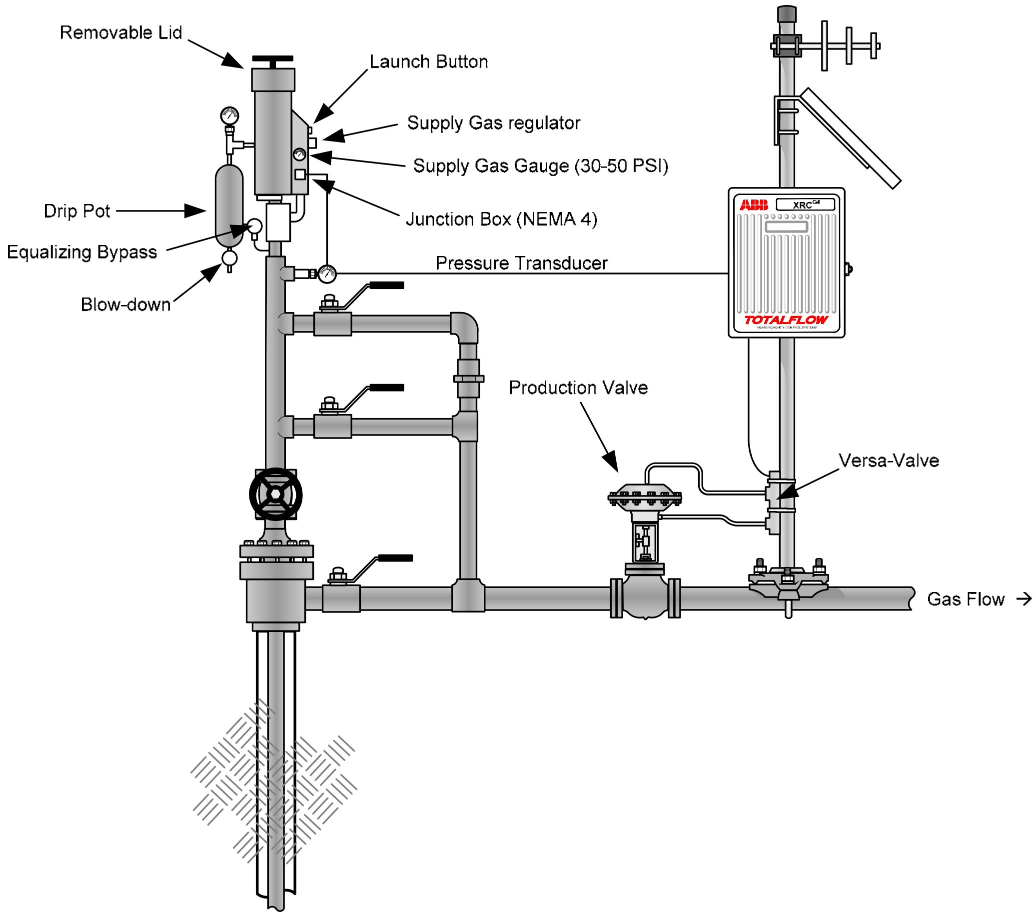
Chemical Injection



Chemical Injection

- Lowers the Critical Velocity needed to lift fluids to the surface
- Precise Injection of Chemical
- Increased Revenues
- Alarm Monitoring
- Controls either Motor Driven Pump or Piston Pump

Soap Stick Launcher



Soap Stick Launcher Control

- Control Launcher based on Flowrate or Critical Rate
- Monitors Flow to determine if another Stick is necessary
- Tracks Sticks remaining in Launcher, alarms when low
- Set # of Sticks to drop before shut-in
- Reset on increase Flowrate

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What is Automation?

Dictionary.com Unabridged (v 1.1) – *Cite This Source* – *Share This*

au·to·ma·tion Audio Help [aw-tuh-mey-shuhn] Pronunciation Key - Show IPA Pronunciation

–noun

1. the technique, method, or system of operating or controlling a process by highly automatic means, as by electronic devices, reducing human intervention to a minimum.
2. a mechanical device, operated electronically, that functions automatically, without continuous input from an operator.

[Origin: 1945–50; AUTOM(ATIC OPER)ATION]

Dictionary.com Unabridged (v 1.1)
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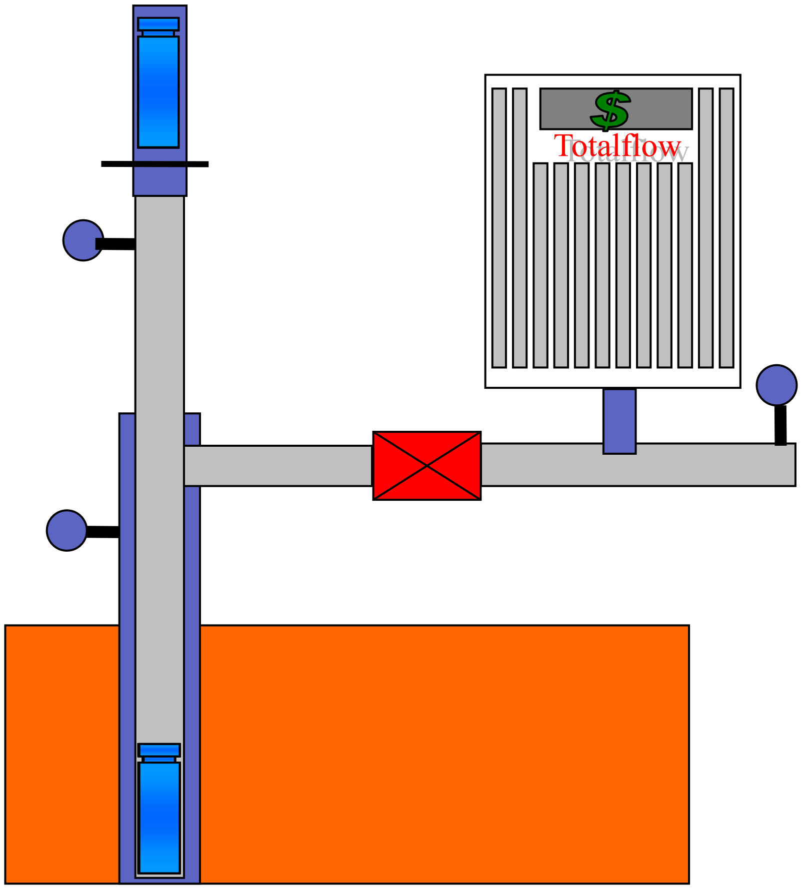
What Does Automation Mean for YOU.

- Spend less time doing tedious manual steps to accomplish simple tasks.
- Become more efficient by learning to use the system or systems to work for you, not you working the systems.
- Let the systems help you become proactive to prevent issues, rather than reactive when an issue happens.
- Let the systems make your job easier.

Questions



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