How to Maintain High Producing Efficiency in Sucker Rod Lift Operations

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(ECHOMETER)
What is High Efficiency?

**Electrical Efficiency**
- Total System Efficiency Should be greater than 50%
- Surface Efficiency should be greater than 80%

**Mechanical Efficiency**
- Pump, Rods, Pumping Unit Size and Balance

**Reservoir Producing Rate Efficiency**
- Should be greater than 95%
High Efficiency?

High **electrical** efficiency, **mechanical** efficiency and **reservoir producing rate** efficiency requires:

a) Measurement of motor power, dynamometer data, the liquid level depth with casing pressure and a representative well test.

b) (Electrical efficiency, mechanical efficiency and reservoir producing rate efficiency) All three must be high for the well to be produced at optimum conditions.
What Should be Known in Order to Analyze a Well?

- Recent and/or Representative Well Test
- Producing BHP & Static BHP
- Dynamometer Data
- Pump Capacity (or, Pump Card)
- Energy Use
- Wellbore Description
- Artificial Lift System Description
- Fluid Properties
- Past History
Analyze Well
To Determine Efficiencies:

1. Analyzes the well’s inflow performance to determine if additional production is available. ( >95% Eff.)
2. Determines the overall electrical efficiency.
3. Analyzes the efficiency of the pump.
4. Analyzes the efficiency of the down-hole gas separator.
5. Analyzes the mechanical loading of rods and pumping unit.
Well Flow Mechanism

Productivity = Flow Rate / Drawdown

Flow Rate = 250 Bbl/Day
Drawdown = 1000 – 500 = 500 psi

PI= (250 bbl/day)/(500 psi) = 0.5 Bbl/day/psi
Determine Well’s Potential using Inflow Performance

- Double the Drawdown does not Double the Production
- The slope is a function of flow rate, defining a curve known as the Inflow Performance Relation or IPR.

Pressure

SBHP

0

Flow Rate, Q

Qmax(PI) = 500 Bbl/D

Qmax(IPR) = 357 Bbl/D

Doubling the Drawdown does not Double the Production

The slope is a function of flow rate, defining a curve known as the:

Inflow Performance Relation or IPR.
PBHP < 10% of SBHP to insure that the well is produced at more than 97% of maximum rate.
Electric Power (kW) and Current (Amps)
Input to the Motor over the time of One Pump Stroke
Efficiency

1. Power Input into Sucker Rod Lift System
   a) System Does Work to Add Energy to Fluids
   b) Fluids then flow to the Surface

2. Discuss Surface & System efficiency

3. Use Fluid Level, Dynamometer, and Power Surveys to Determine Efficiency

4. Low Efficiency Used to Identify Problems

5. How to maintain a high producing efficiency in sucker rod lift operations
Net Lift ~ System Efficiency Equation

System Efficiency = \frac{HHP}{INPUT HP}

HHP = \frac{SG \times BPD \times (Net \ lift)}{135,800}

INPUT HP = Motor Power

SG = Specific Gravity of Fluid

1 HHP/D = 27 BPD x 5000 Ft
Measure Motor Input = 13.9 kW

Acquire:
- RMS (thermal) motor current
- Average (real) motor current
- kW during a pump stroke cycle.
Pump Intake Pressure = 730.7 Psig  133 BOPD
Tubing Fluid Gradient = 0.335 psi/ft  241 BWPD
Determine:
1. Input Kw
2. PR Hp
3. Pump Hyd Hp
System Efficiency Calculation

Theoretical amount of work required to lift the liquid from the intake pressure at the pump to the surface divided by the energy supplied to the motor.

Measure:

- Pump Intake Pressure from Acoustic Liquid Level

Net Lift = \( P \) Depth – PIP/ .433xSG

= 5059 – 730/0.335 = 2880 ft

- Fluid Volumes and Properties
- Motor Input Power Measurement
55% System Efficiency
Why is Efficiency a Useful Benchmark?

- Measure of work input (power requirements) relative to useful output (liquid production).
- Directly related to operating costs
- Relatively easy to measure
- Generally accepted guidelines

**Efficiency**

- System Efficiency should be > 50%
- Surface Efficiency should be > 80%
Losses ~ System Efficiency

Input HP = Kw / 0.746
60 Hp NEMA D Motor (Surface Efficiency)

Motor Performance Data – Efficiency vs. Output Hp

Other Motor Manufacturers Efficiency may be Different

Other Motor Manufacturers Efficiency may be Different

NEMA D MOTOR HORSEPOWER RATINGS:

- 5  - 7.5  - 10  - 15  - 20  - 25  - 30  - 40  - 50  - 60  - 75  - 100

(Polished Rod Horsepower can be used to estimate for Motor)
Surface Efficiency measured over one revolution of the crank is an excellent indicator of the operating performance of the surface equipment.

Surface Efficiency includes losses per crank revolution in wirelines, structural bearings, transmissions, V-belts, and the electric motor.
Example of Low Surface Efficiency

Bad Tail Bearing Resulted in Low Surface Efficiency of 66.5%

Before

Surface Efficiency of 83.0% After Repair of Bad Tail Bearing

After
Oil Lifting Cost, 8000 ft net lift, $0.05/kwh
Water Disposal Cost, $0.07/Bbl
Use Both Producing Fluid Level Survey and Dynamometer Analysis to Answers the Following Questions:

1. Is the well being produced at its maximum production rate?
2. Does a fluid column exist above the pump intake?
3. Is the pump completely filled with liquid?
4. Is low efficiency caused by incomplete pump fillage due to over-pumping the well or due to gas interference?
Acoustic and Power Surveys Show System Efficiency Less Than 35%

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Tubing Leak?
Acoustic and Power Surveys Show System Efficiency Greater Than 35%

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Low Efficiencies of Sucker Rod Lifted Wells Are Often Caused by Partial Pump Fillage

- More efficient operations and lower electrical power usage will result if wells are operated with a pump filled with liquid.

- Full pump fillage also requires an efficient downhole gas separation that results in a full pump if sufficient liquid is present to fill the pump.

- Full pump fillage generally requires controlling the run time of the pumping unit to match the pump capacity to the maximum well inflow rate.
HOW TO MINIMIZE ELECTRICITY USAGE?

◆ Maintain a high pump volumetric efficiency:
  • Match pumping unit capacity with wellbore inflow.
  • Pump a Full Stroke of liquid by controlling run time with a POC or Timer
  • Eliminate Gas interference.

◆ When System Efficiency is low, find and fix problem.

◆ Mechanically/Electrically balance pumping unit.

◆ Properly size pumping unit, rods and pump to match well loads.

◆ On severely over-sized motors where surface efficiency falls below 50%, reduce motor size.
Periodically Monitor Well’s Operations To Maintain Efficient Operations

1. Check pump for proper operation

2. Produce all available liquid from the Wellbore

3. Operate well with high volumetric pump efficiency

4. Use POC or TIMER to reduce run time if pump capacity exceeds production rate
1. Uniform loading of pump and pumping unit reduces maintenance.
2. Operating the pumping unit a portion of the time subjects the unit to less wear and tear.
3. Fluid pound should be minimized.
4. Reduced shock loading results in decreased rod buckling, pump wear, tubing wear, excessive rod loading changes and pumping unit vibration.
5. Reduction of shock loading reduces maintenance costs.
Maintaining High Efficiency in Sucker Rod Lift Operations Results in:

1. Reduced Electrical Costs
2. Reduced Mechanical Operating Expense.
3. Increased in Oil and Gas Production.
4. Longer Run Times Before Failure.
Questions?