Controlling Runtime

Marginal Oil and Gas Well Commission of Oklahoma

Many Sucker Rod Lifted Well Problems Often Caused by Partial Pump Fillage

- More efficient operations and lower electrical power usage will result if wells are operated with a pump that is filled with liquid.
- Full pump fillage also requires an efficient downhole gas separator 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.

Optimize Efficiency of Well Before Installing TIMER or POC

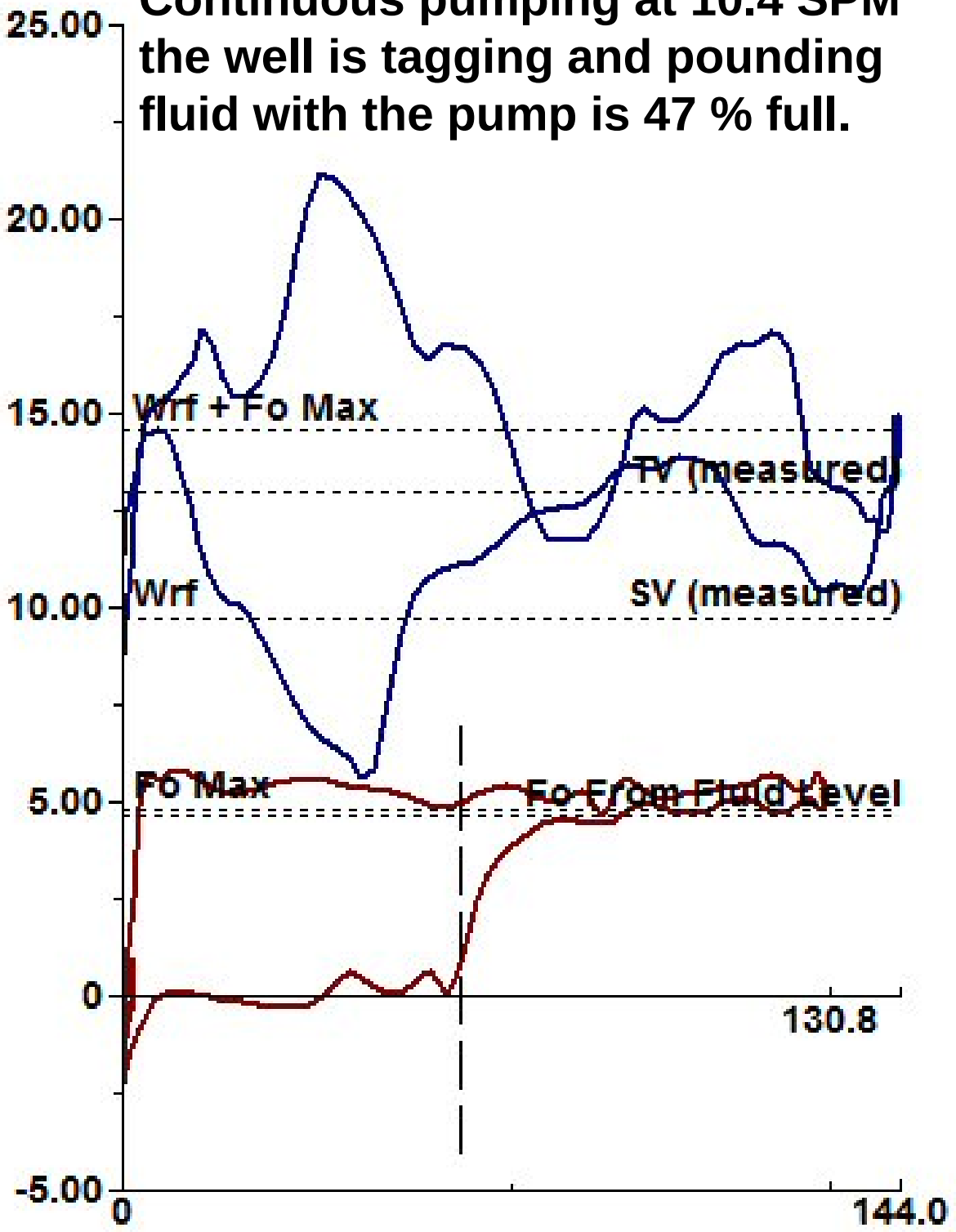
- Is the PBHP low compared to SBHP at all times?
- Is the mechanical equipment properly loaded?
- Is the pump full of liquid when liquid exists in the casing annulus above the pump?

Pump OFF and Tagging

Pump intake is set below the fluid and gas entry zone and the well initially starts with the pump filled with fluid.

For efficient operation and reduced risk of failure:

1) Re-space pump
2) Reduced to 5 SPM or control run time using a percentage timer or POC.



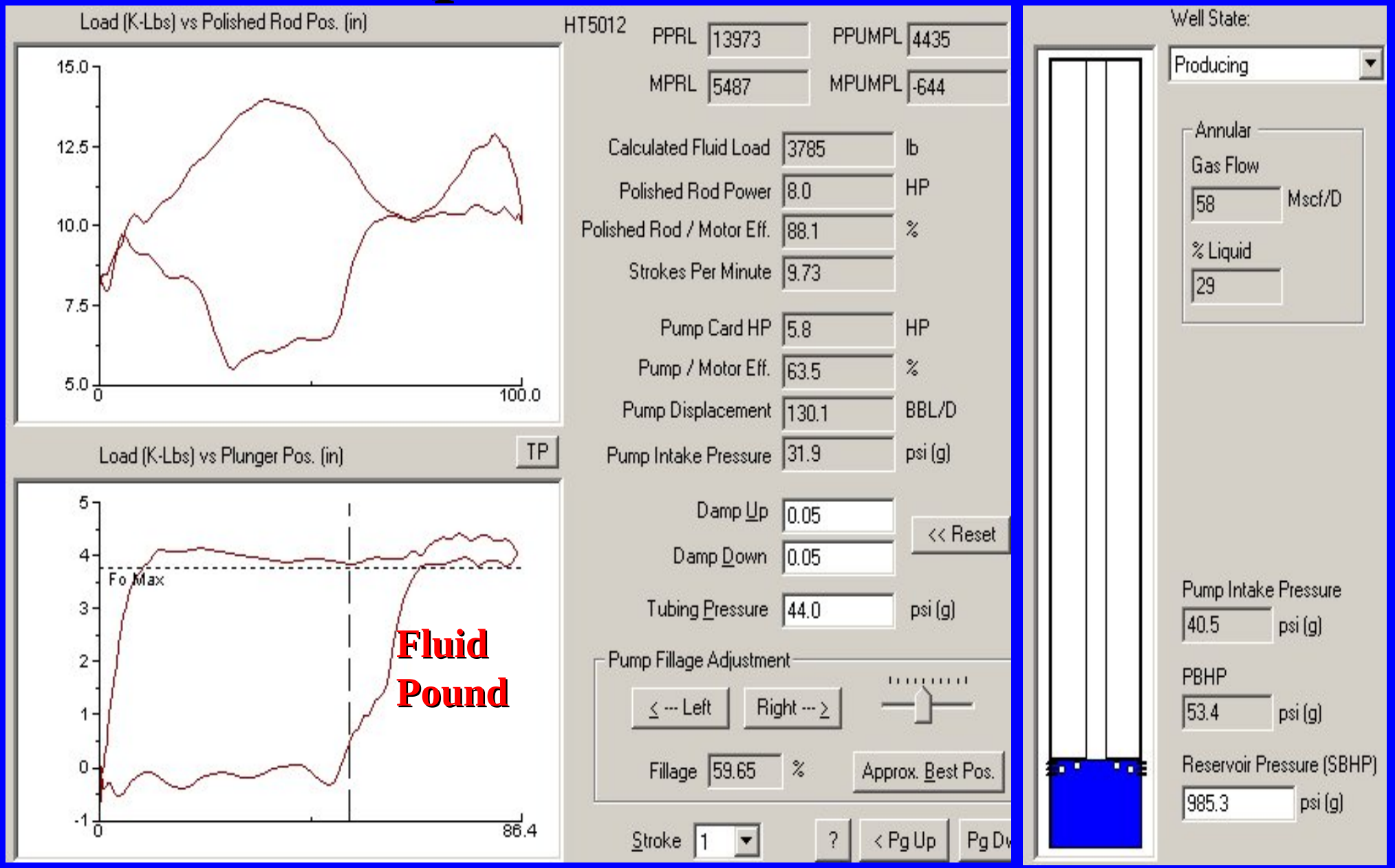
Best Wells for Controlling Run Time

A well with a high static pressure and a low PI is a good well for POC.

Because during the down-cycle, the well will continue to flow into the well annulus.

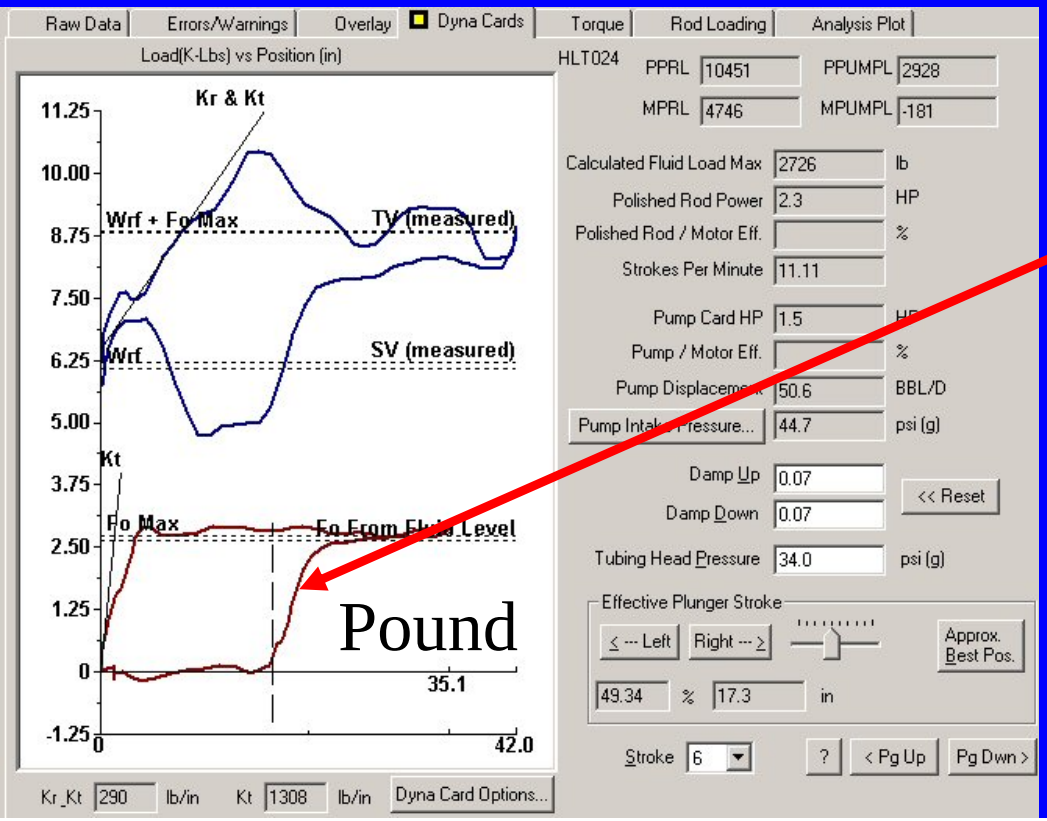
Pumping capacity should be designed such that the unit will pump about 120-130% of the maximum that the well will inflow.

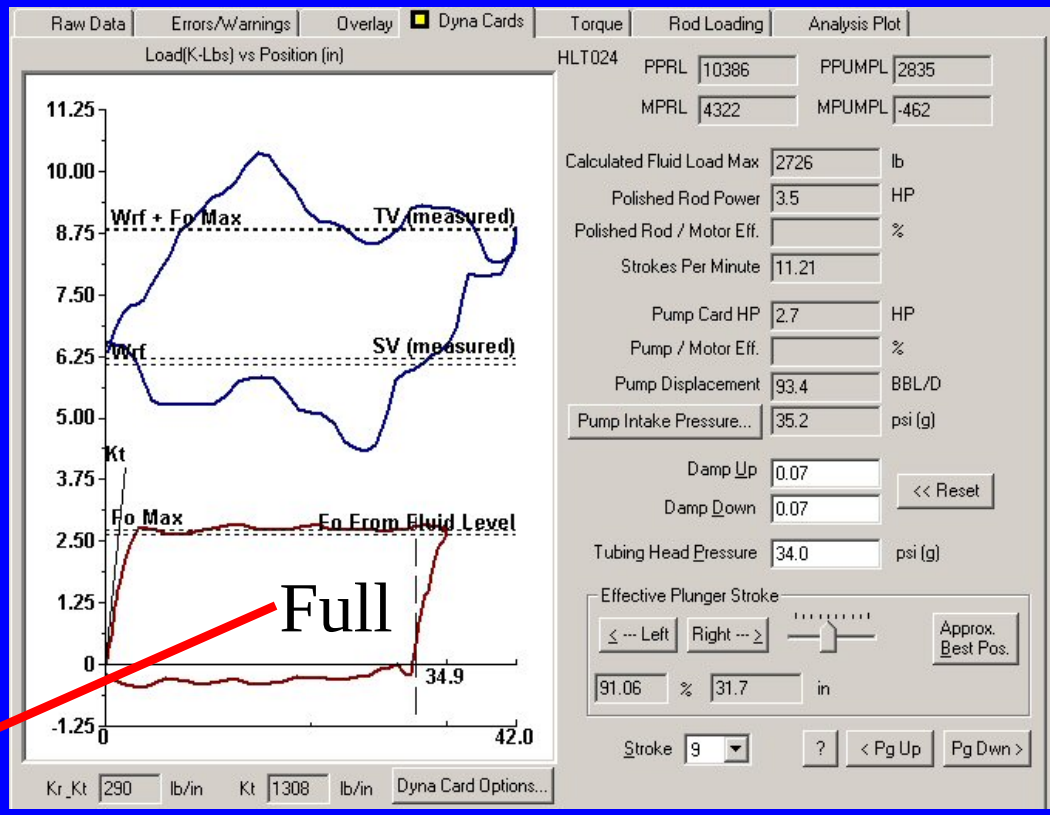
Fluid Level @ Pump - Fluid Pound?
Timer or Pump Off Controller Candidate



From Full Pump to Pound

Pump Capacity Exceeds Inflow of Fluids from Well.





Control Pump Run time by Matching Pump Displacement To Inflow of Fluids from Well.

Problems Associated with Pounding Fluid

Pounding causes vibration throughout the whole system. This causes:

- Rod buckling
- Pump wear
- Tubing wear
- Vibration stresses
- Severe rod loading changes
- Pumping unit vibration

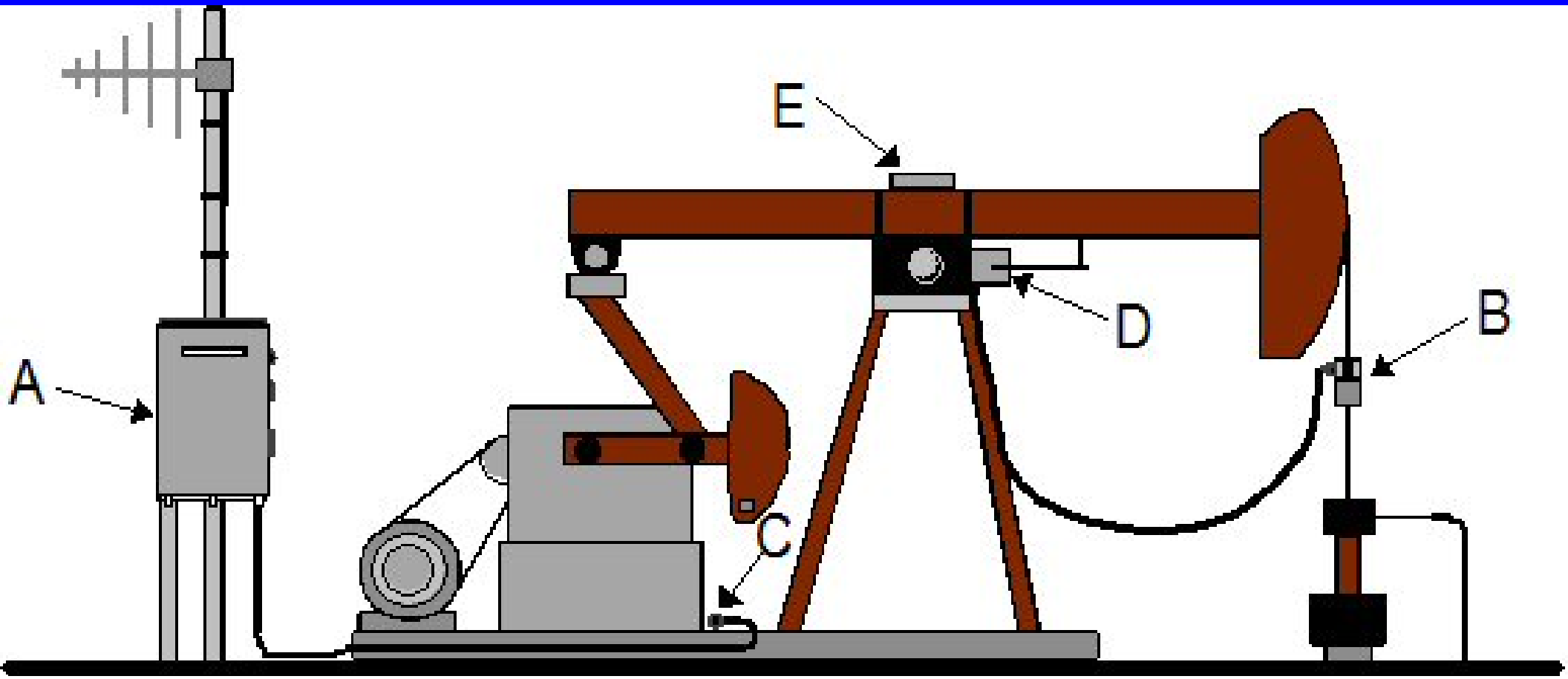
Timers and Pump-off Control Systems

- Both timers and pump-off control systems can be used to control a pumping unit motor
- Timers are preset to turn the motor on and off at specific times
- Pump-off Control systems shut down the motor when partial pump fillage is detected, then, turn the motor on after a preset elapsed time

Instrumented Beam Pump System

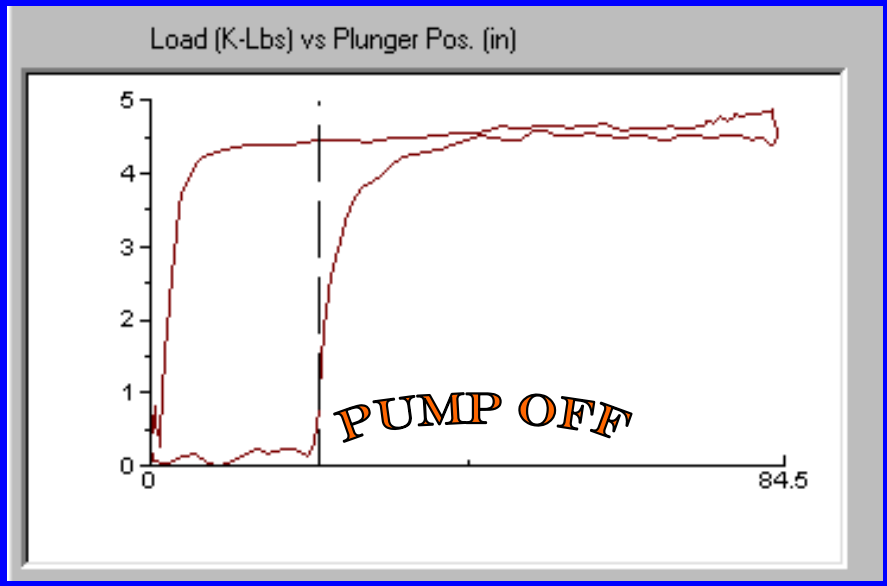
(Courtesy Weatherford, EP Systems)

A - Rod Pump Controller B - Polished Rod Load Cell C - Position Sensor Switch
Optional: D - Continuous Position Transducer E - Beam-Mounted Strain Gauge



Pump-off Control System

- POC monitors pump fillage when the motor is operating
- POC shuts down the motor when partial pump fillage is detected
- After a preset down time, POC starts the motor and again monitors pump fillage

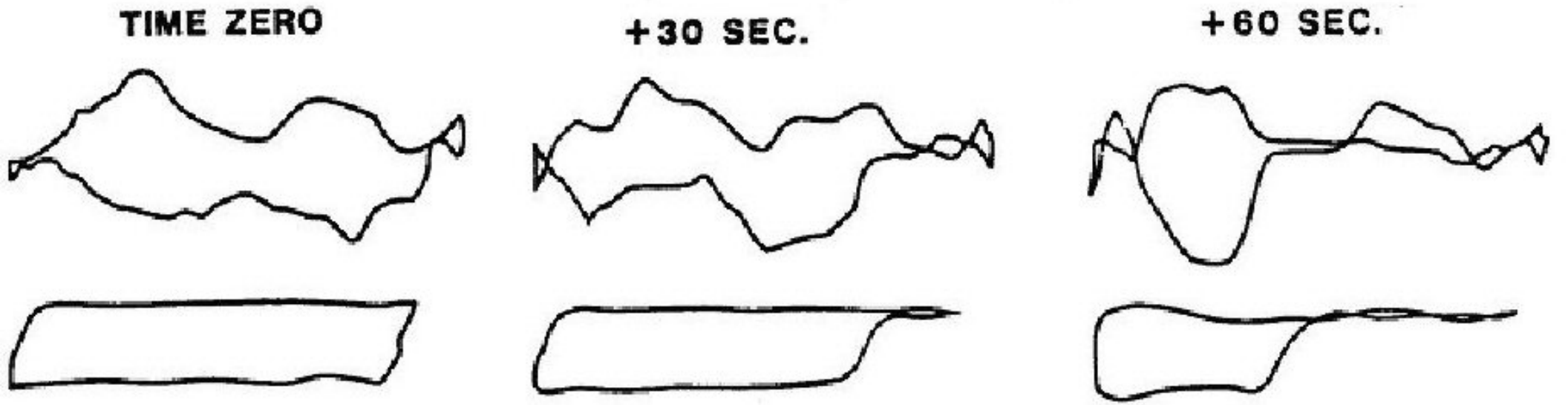


Pump Card

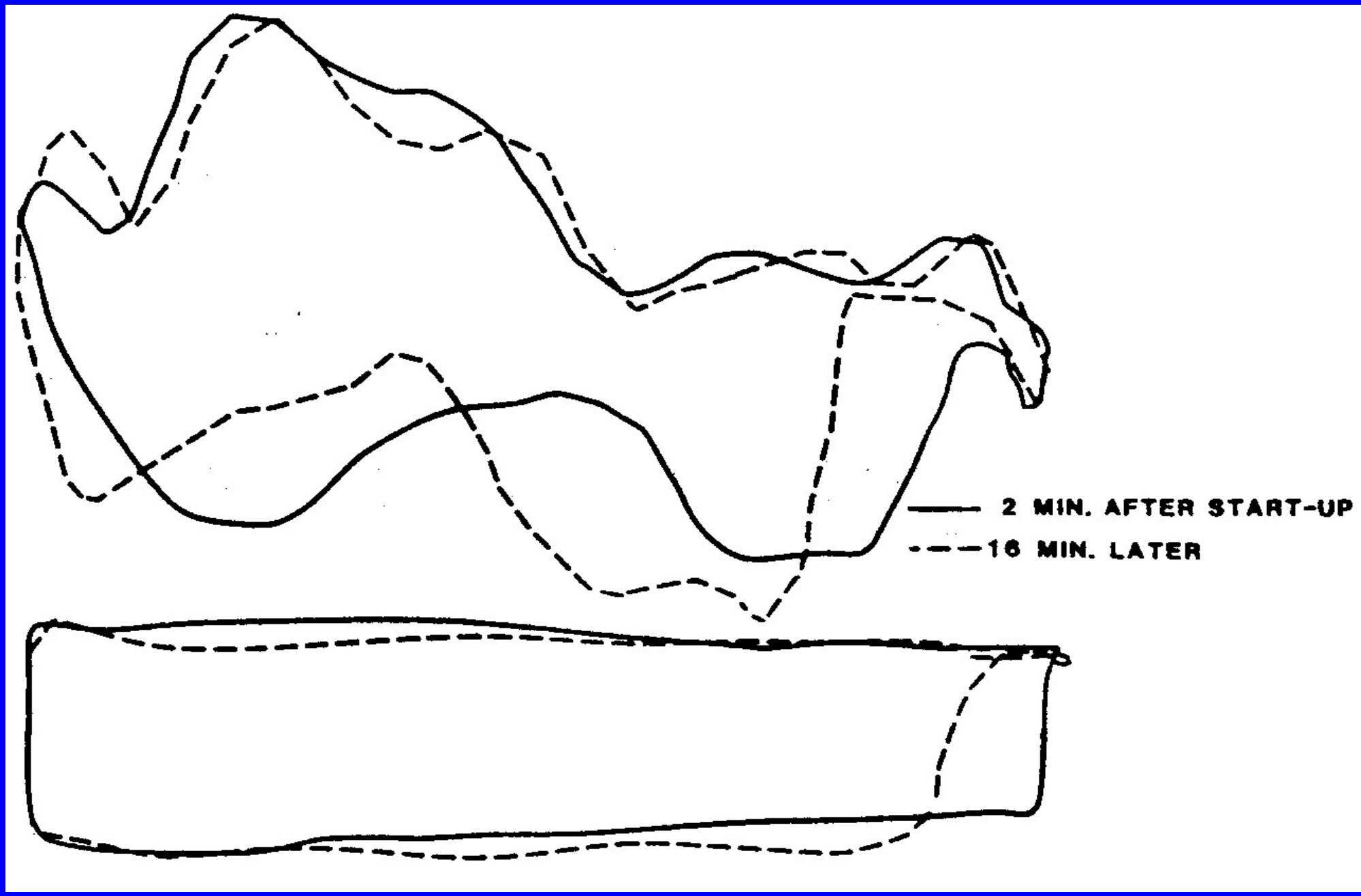
Surface and Bottom Hole Dynamometer Cards

Progressing from

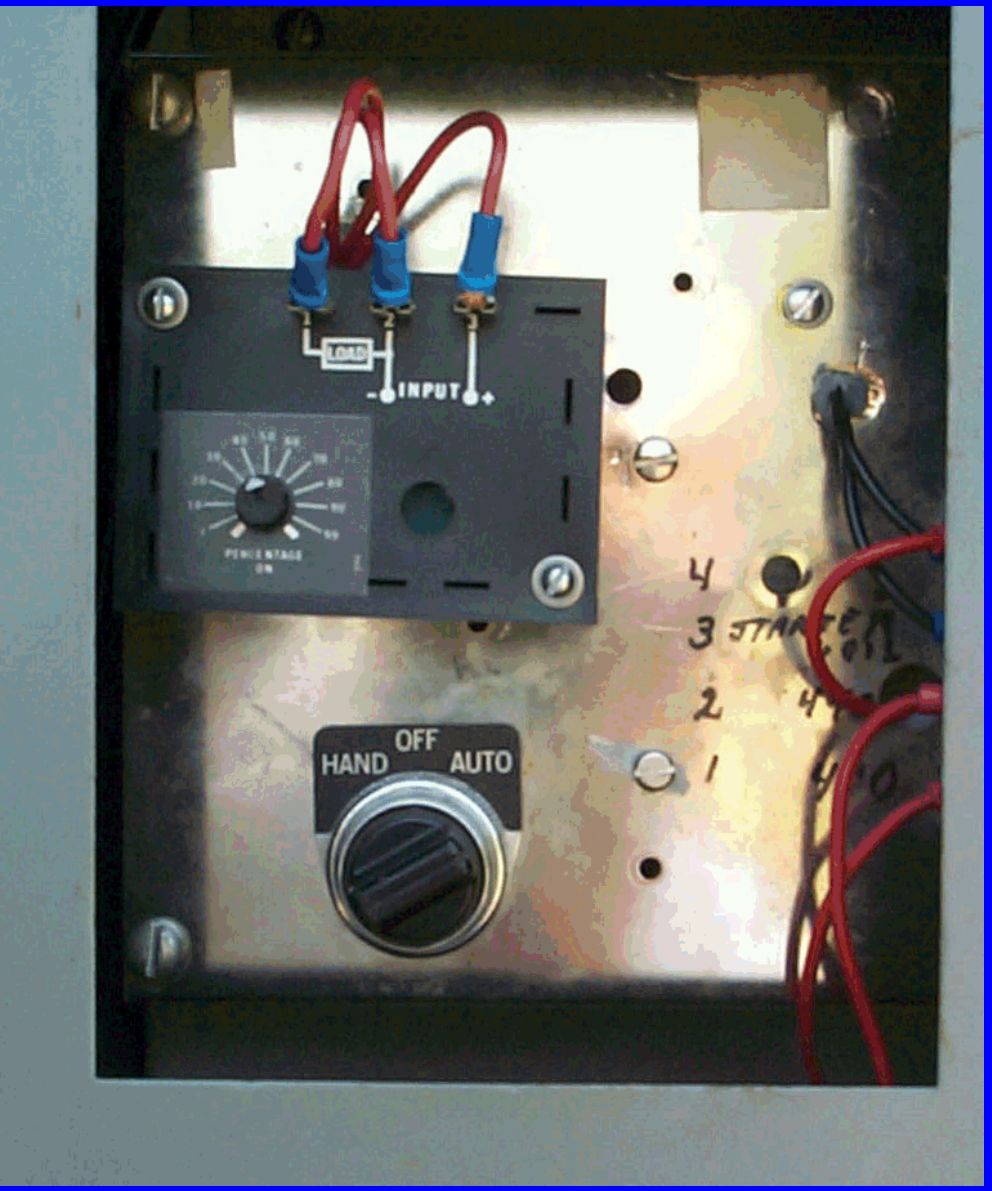
1. Full
2. to about 80% pump fillage
3. to about 50% pump fillage.



Set points for POC: About right

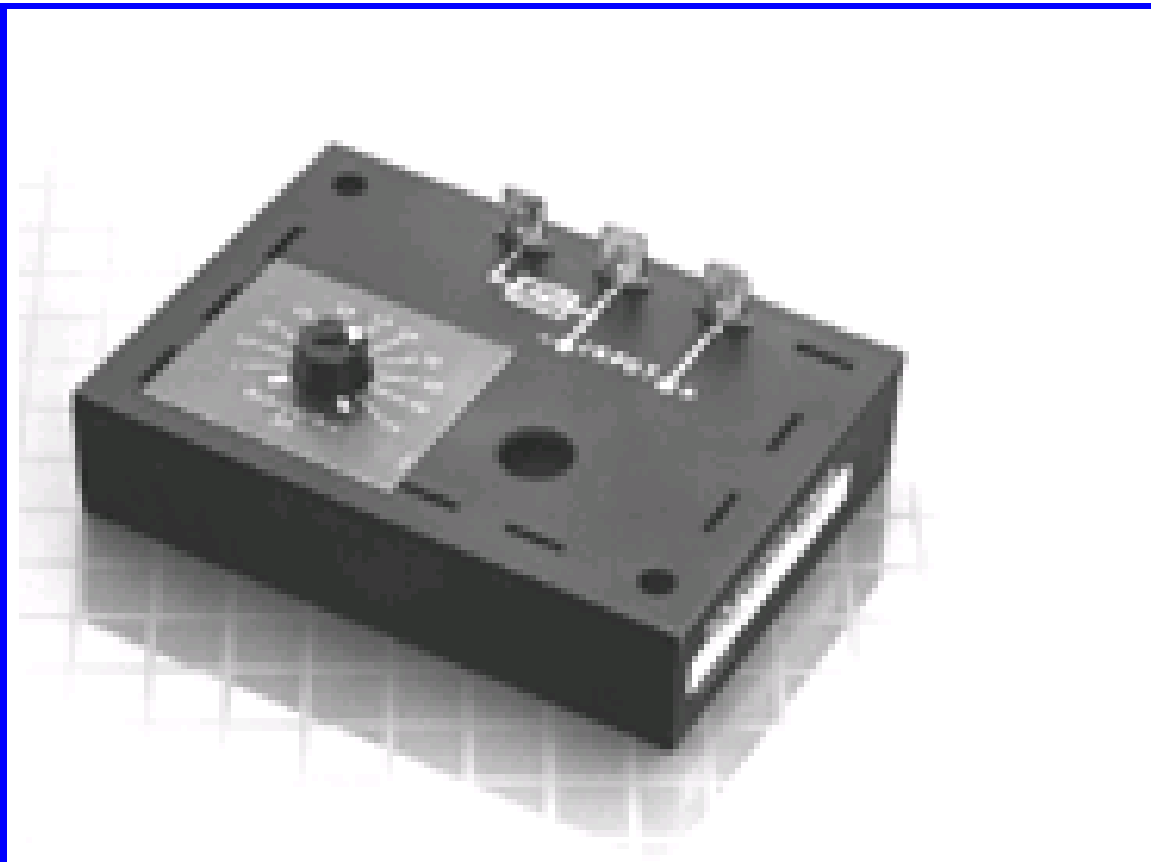


15 Minute Percentage Timer



- Reduce electricity demand charges
- Relatively simple to operate
- Relatively inexpensive
- Should be considered for low cost intermittent pumping unit operation
- Timers must be manually set.

Timers



Two style of timers are used in the oilfield. A percentage timer controls the percentage of time that the pumping unit operates.

A interval timer controls the time intervals (usually 15 min) which the pumping unit operates.

They can cost from $25 to $200 each.

Wellbore Pressure at End of Off Cycle

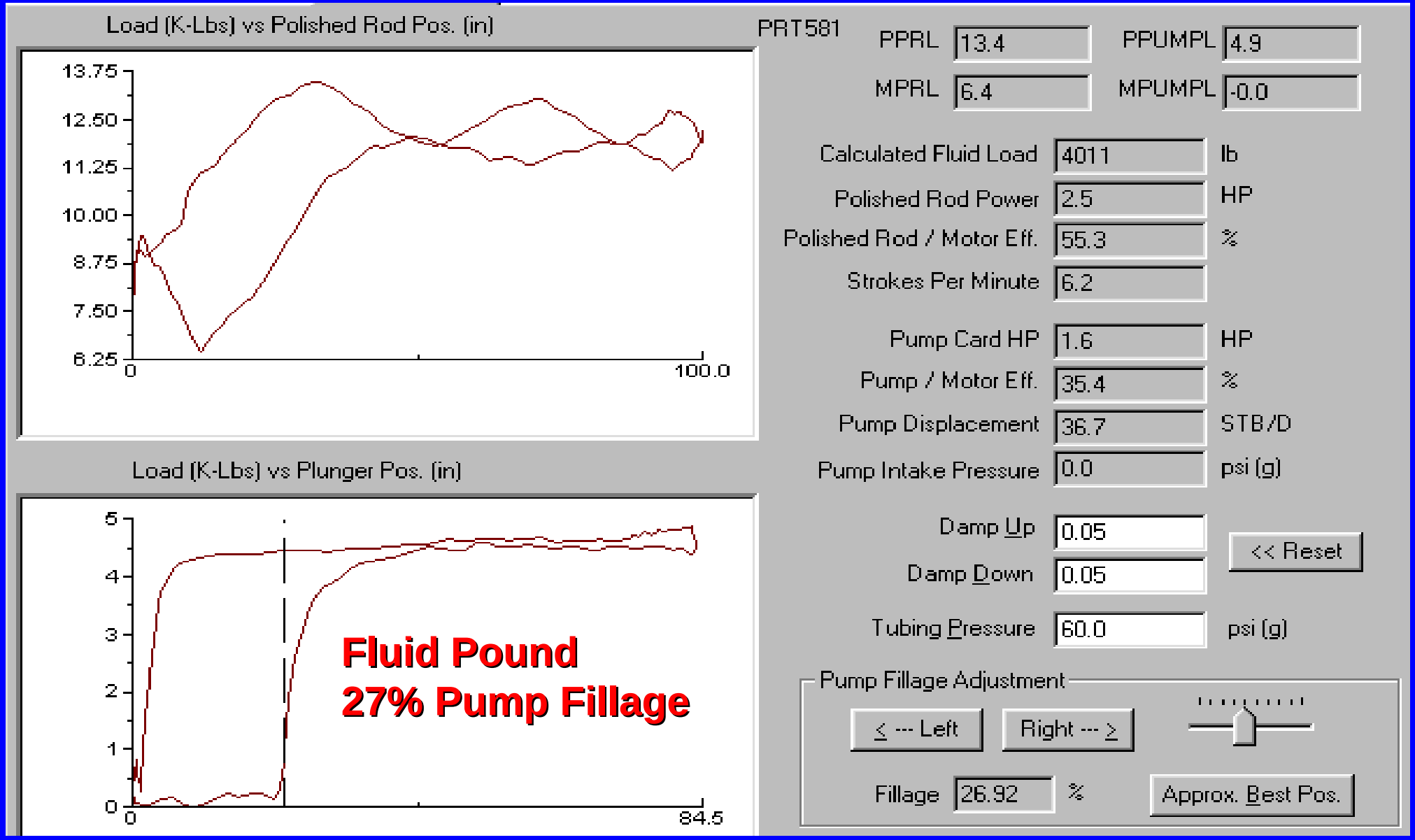
- Wellbore pressure at end of off cycle should be < 10% of SBHP
- An estimated wellbore pressure at the end of the off cycle can be calculated from the well test, casing size, tubing size and casing pressure
- Best procedure is to shot fluid level at the end of the off cycle for PBHP (<10% SBHP)
- A 15 minute on and off cycle time generally results in a low PBHP in most wells

Percentage Run Time from Well Test and Pump Capacity

- Desired percentage of pumping unit operating time is approximately the percentage of pump capacity that equals the well's production rate

- 25 % of 200 BPD (pump capacity) = 50 BPD (well's maximum production rate)

Percentage Run Time from Surface and Pump Dynamometer



Procedure to Initially Set the 15 Minute Percentage Timer

- **Initial Setting**
  - Percentage of dynamometer pump fillage when the well is produced continuously.
  - Percentage of QRod calculated pump capacity that equals the well's maximum liquid production rate.

Procedure to Adjust the Percentage Timer - continued

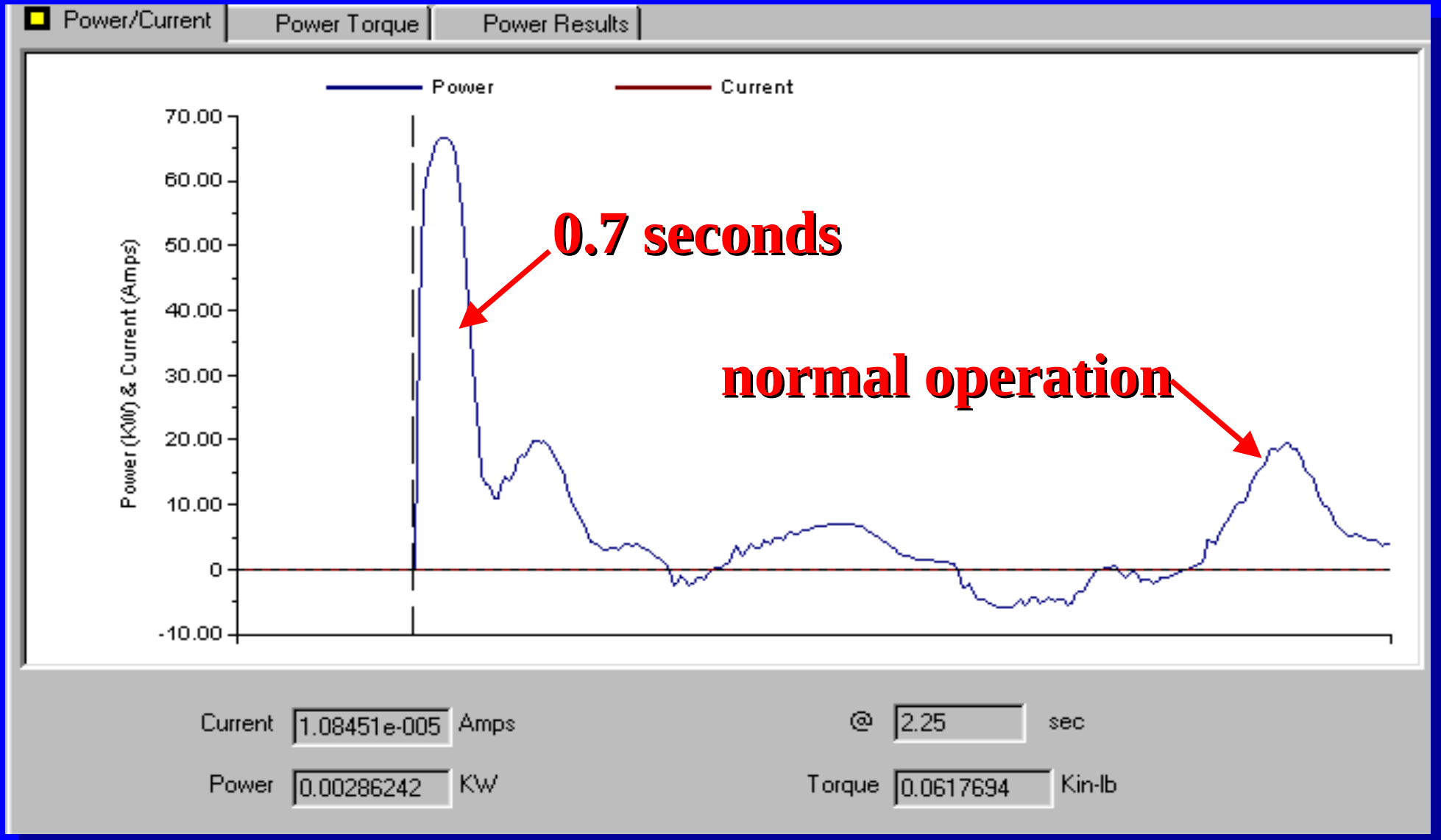
- Stroke Count (for adjusting timer)
  - Increase run time if the pump is full at the end of the run cycle
  - Decrease run time if the well "Pounds Fluid" excessively at the end of the run cycle

Start-up Power Consumption

- A beam pump motor during start-up uses approximately 3 times full load power for about 0.7 seconds

- Electricity usage during start-up is less than electricity usage during one stroke of normal operation

Startup Motor Power

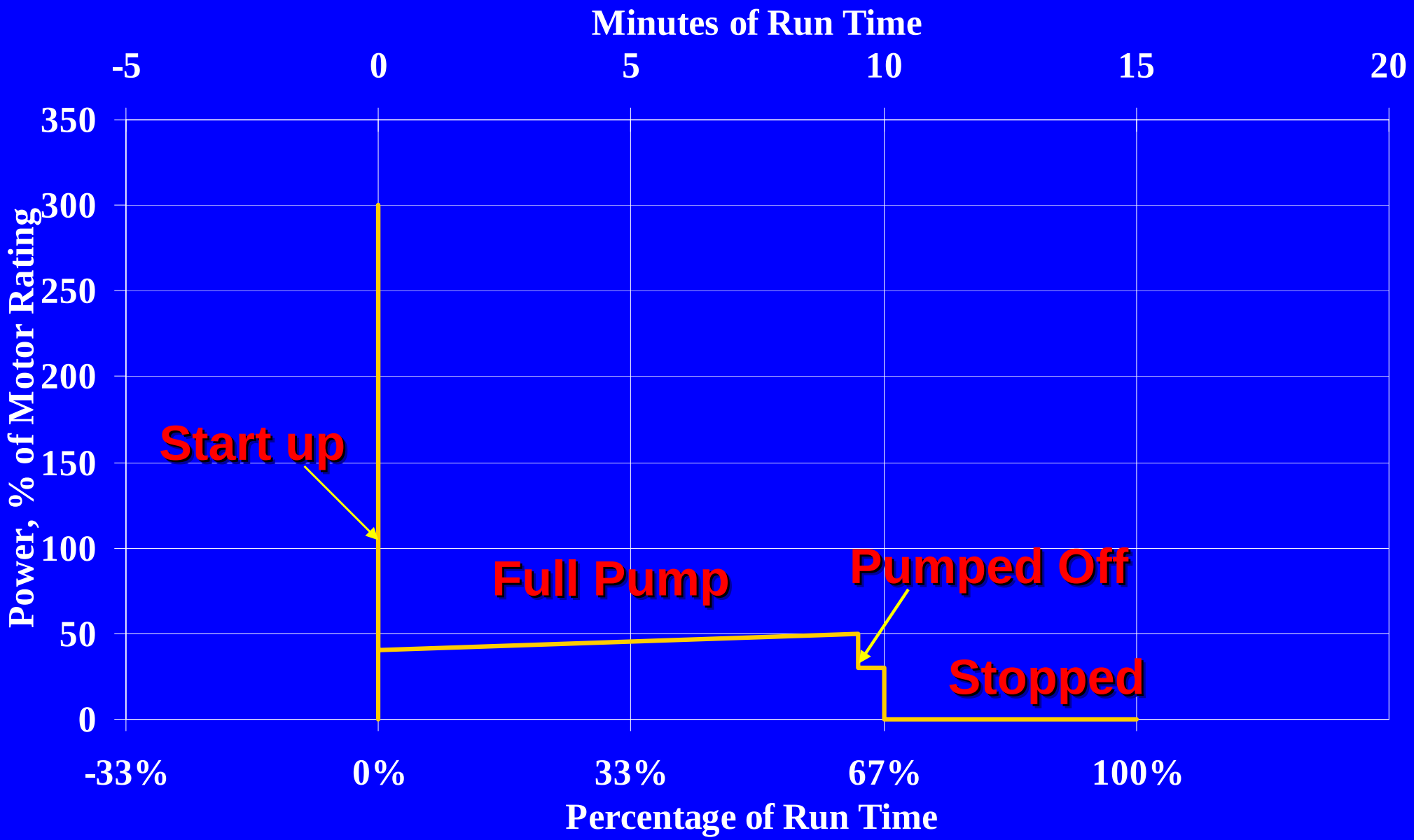


Minimizing the Demand Charge

- **Average electricity demand during a 15 minute period will be minimized when the motor demand during operation is averaged with zero demand during motor rest which necessitates that both the on and off cycles occur within a 15 minute period.**

- Demand will be minimized when the on and off times total 15 minutes

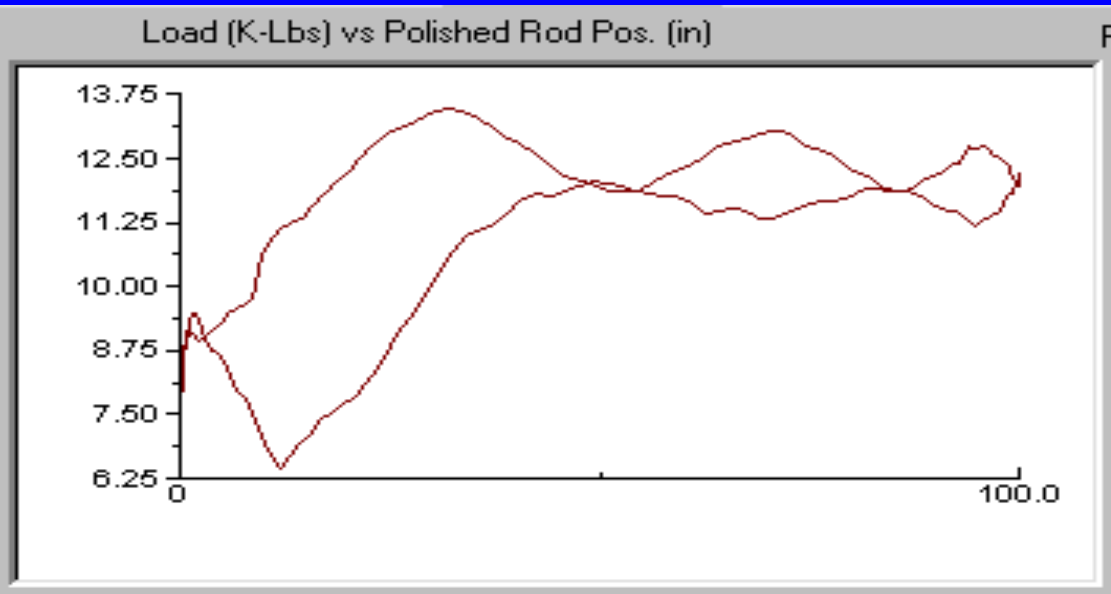
Power Usage During Intermittent Motor Operation

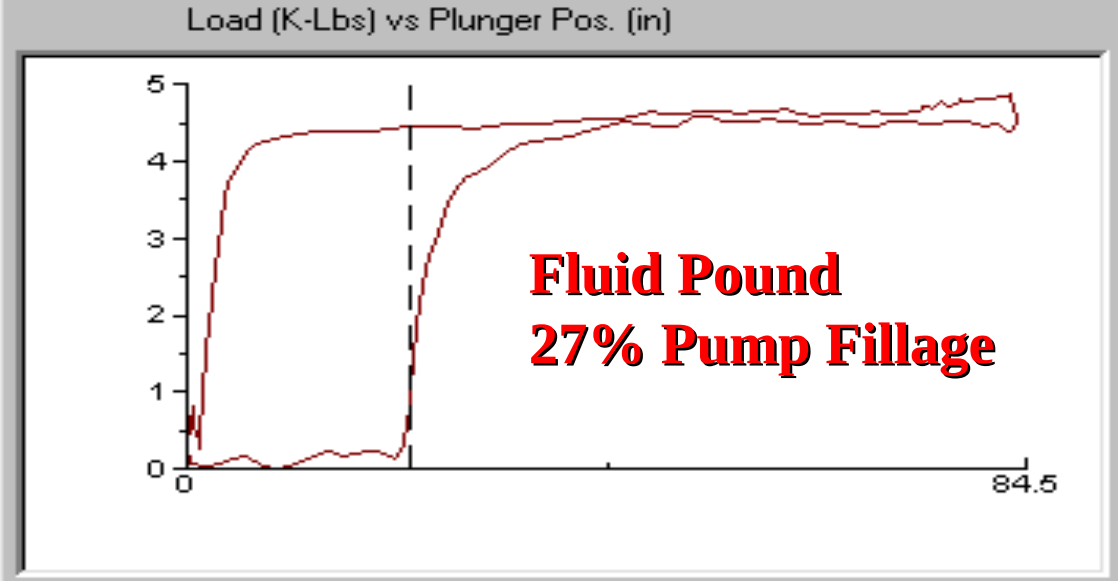


Electricity Cost Comparison
With Cycle Times of 15 Minutes and 12 Hours

Cycle Time	12 Hour	15 Minute
On Time	1 Hour	1.2 Minutes
Motor Power	20 HP	20 HP
Consumption Charge	$54	$54
Demand Charge	$120	$12
Total Monthly Cost	$174	$66

Dynamometer Test
Continuous Operation





PRT581

PPRL	13.5	PPUMPL	4.9
MPRL	6.5	MPUMPL	0.0

Calculated Fluid Load	3990	lb
Polished Rod Power	2.5	HP
Polished Rod / Motor Eff.	55.3	%
Strokes Per Minute	6.2	
Pump Card HP	1.6	HP
Pump / Motor Eff.	35.4	%
Pump Displacement	36.7	STB/D
Pump Intake Pressure	143.6	psi (g)
Damp Up	0.05	
Damp Down	0.05	
Tubing Pressure	60.0	psi (g)

<< Reset

Pump Fillage Adjustment

< --- Left | Right --- >

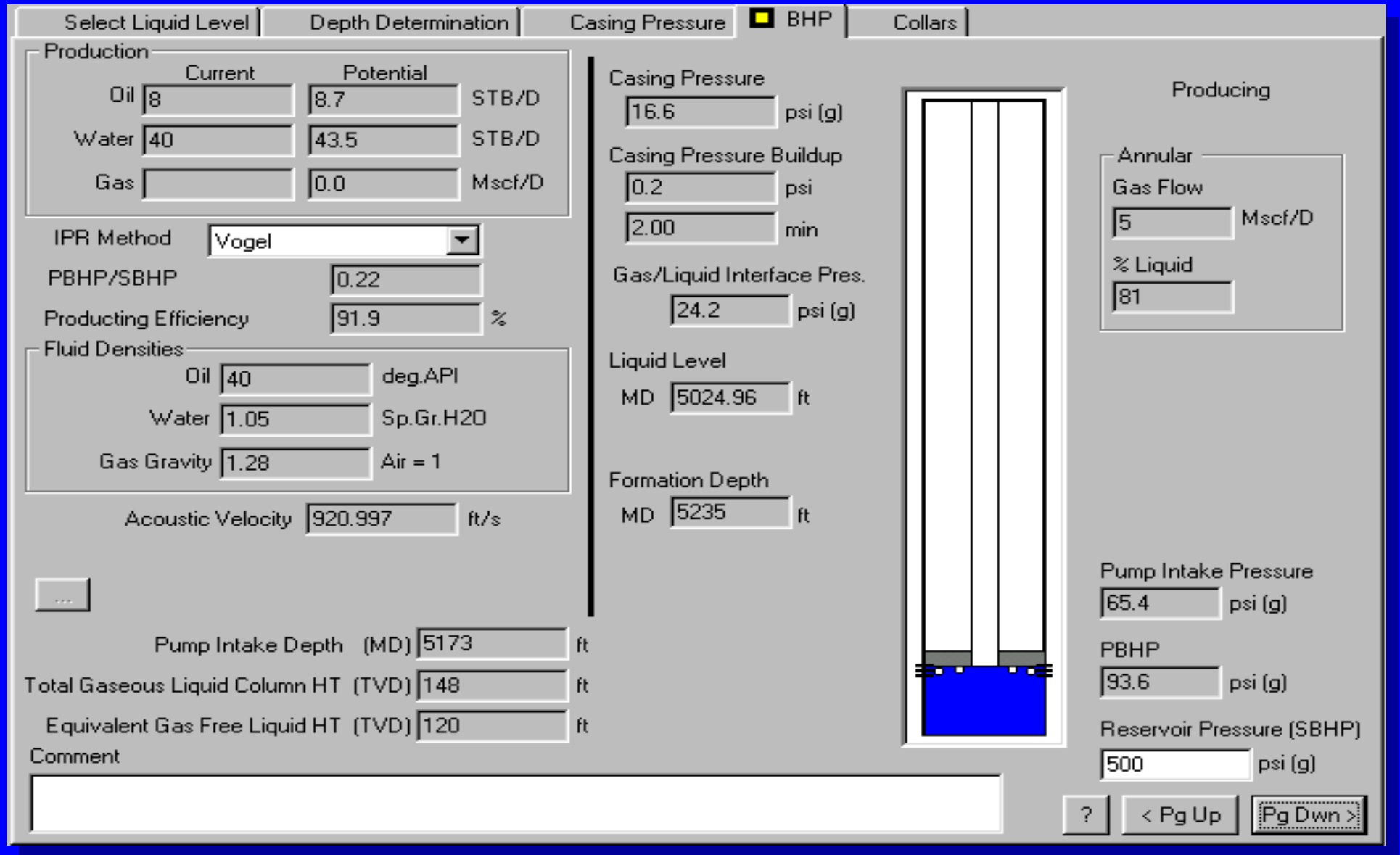
Fillage 26.92 %

Approx. Best Pos.

Stroke 1

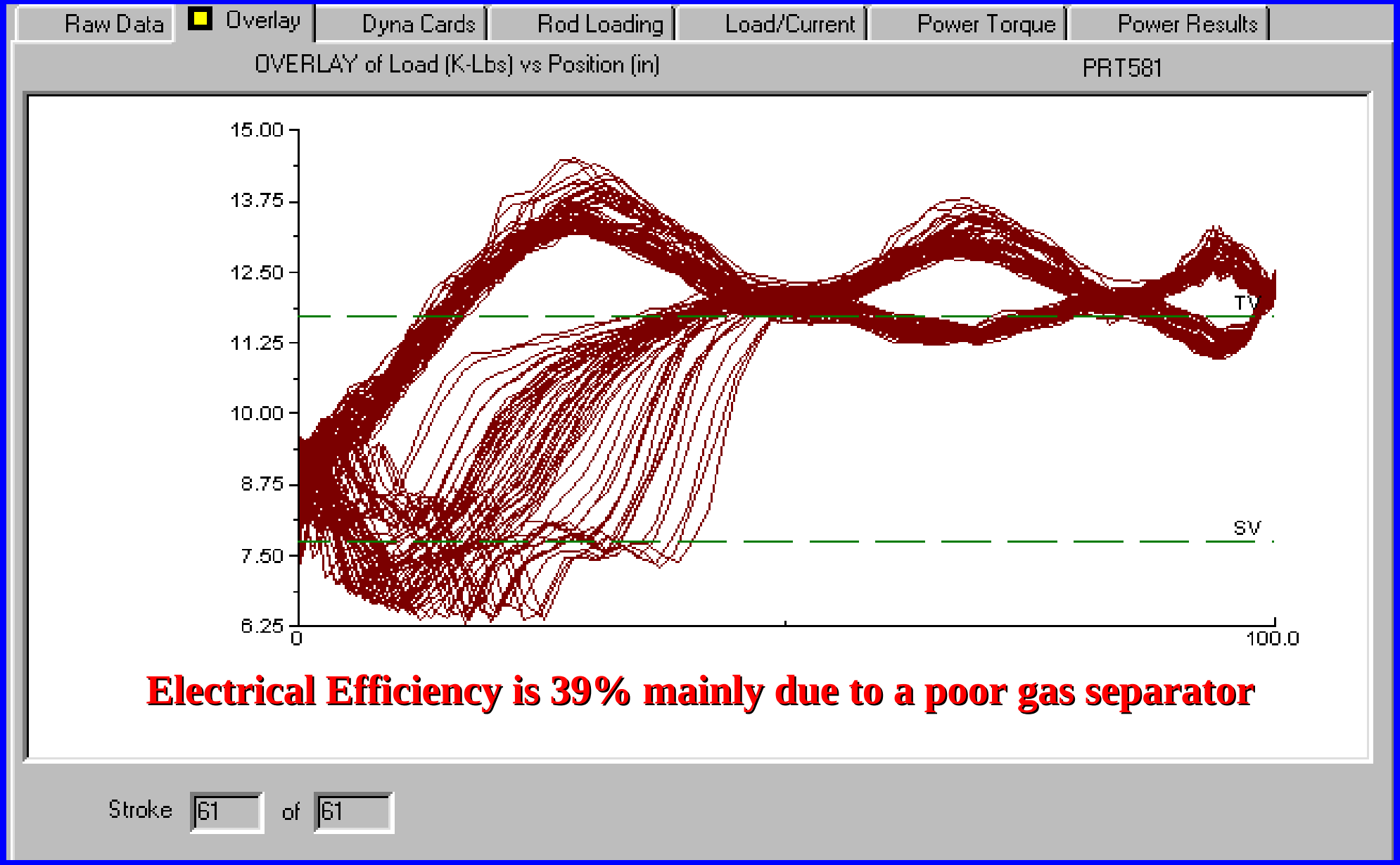
? | < Pg Up | Pg Dwn >

Acoustic Test
Continuous Operation



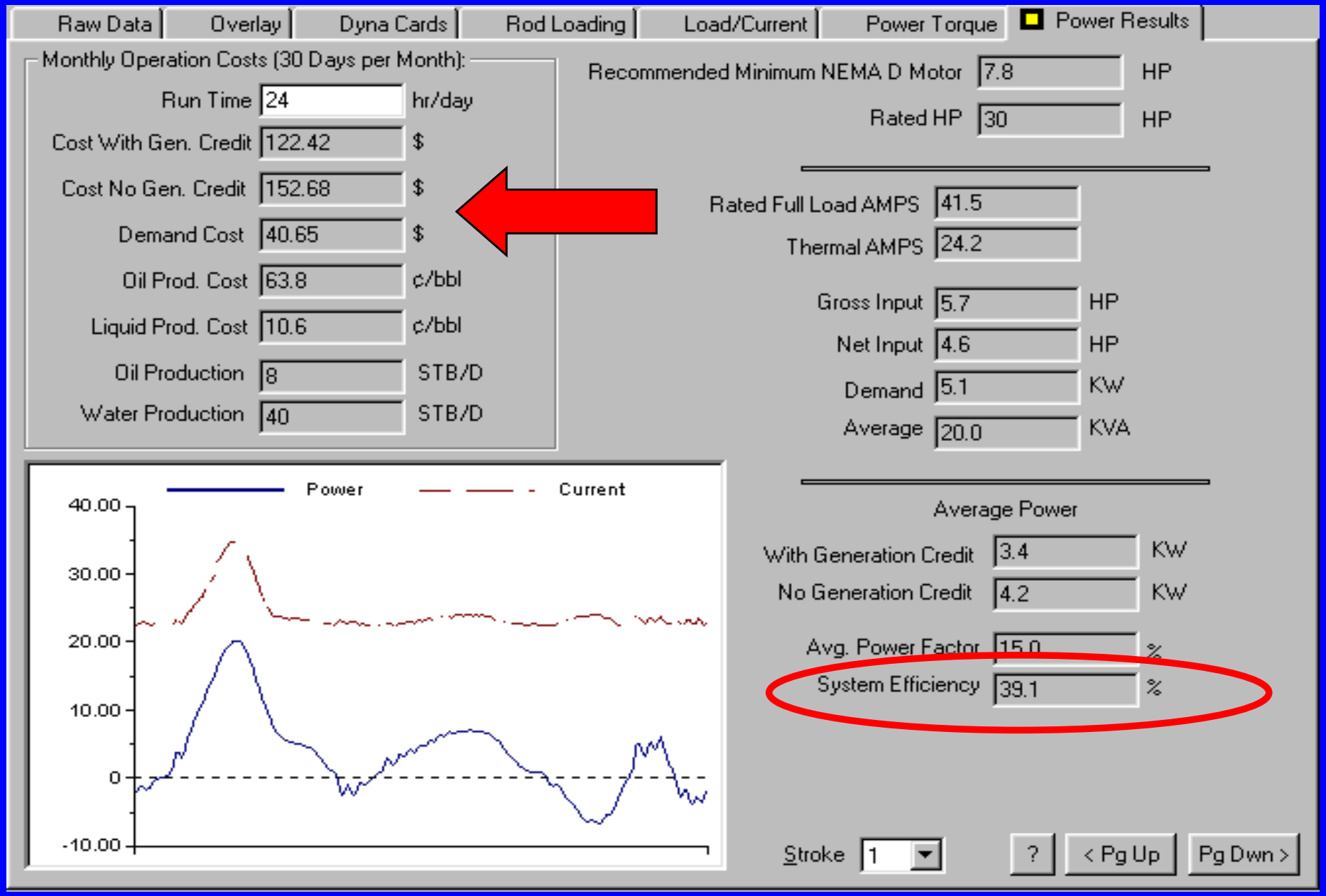
DYNAMOMETER TEST

61 Strokes immediately after well down for 10 minutes. Starts up With Low Pump Fillage Indicates Poor Downhole Gas Separation



Electrical Efficiency is 39% mainly due to a poor gas separator

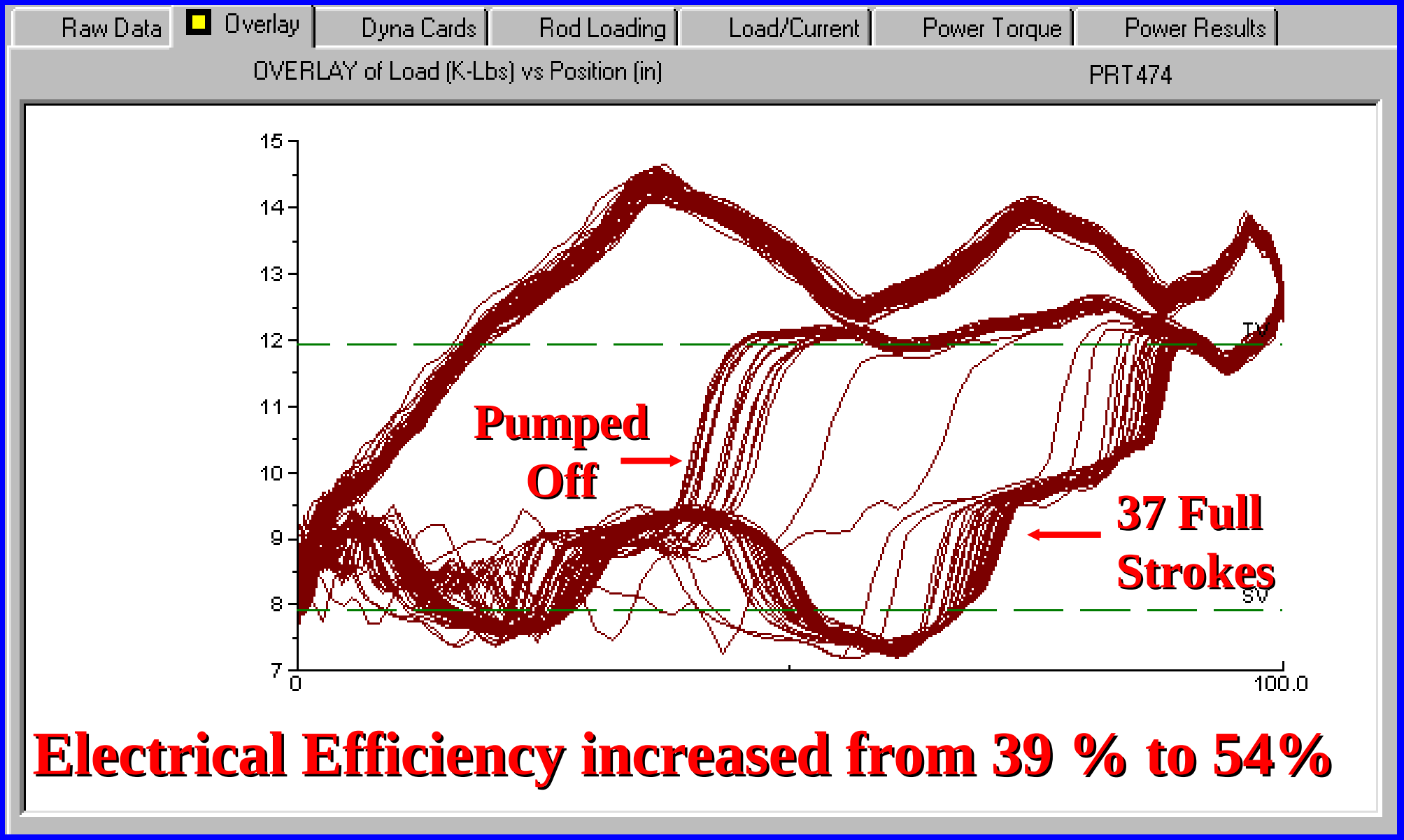
Initial Power Analysis



REWORK

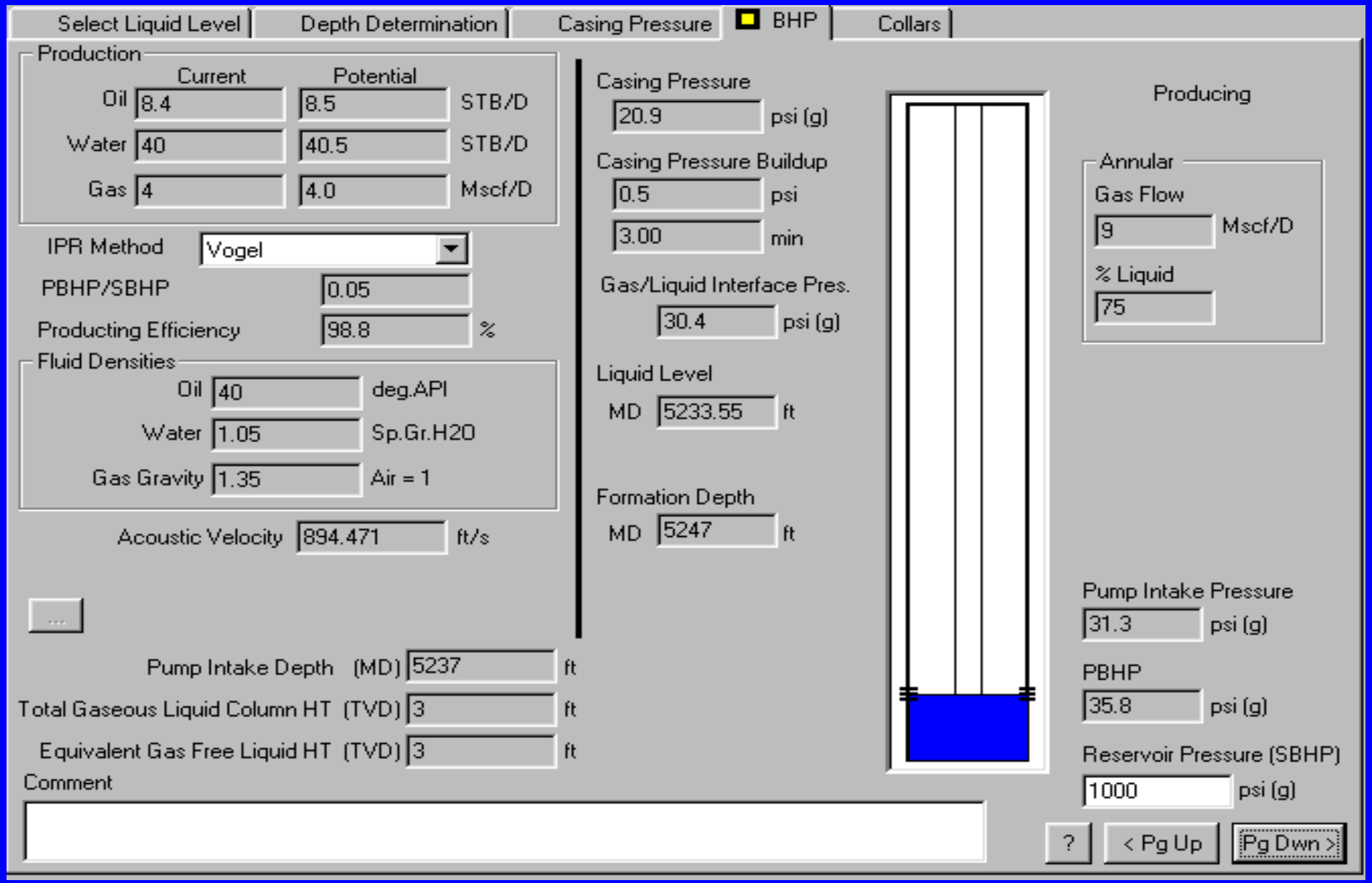
- REDUCE PBHP TO A MINIMUM
- INSTALL COLLAR SIZE GAS SEPARATOR
- INSTALL TIMER

After Installation of Collar Sized Gas Separator, Well Starts Pumping with Complete Pump Fillage After Being Down 10 Minutes



Electrical Efficiency increased from 39 % to 54%

Acoustic Test After Collar Size Gas Separator Installation

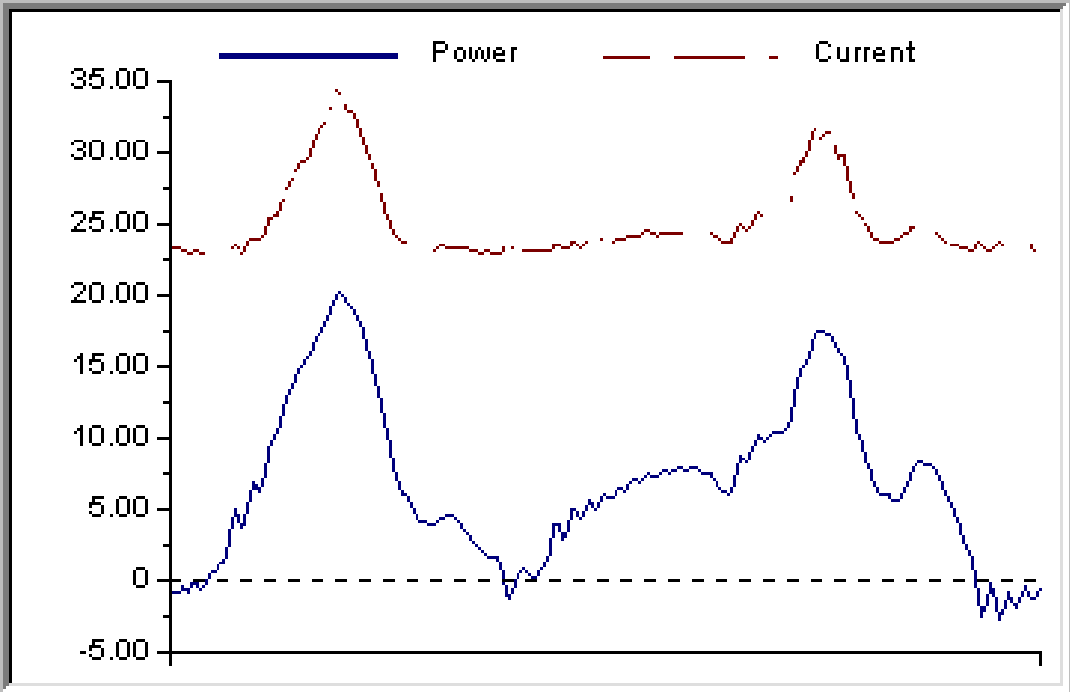


Raw Data | Overlay | Dyna Cards | Rod Loading | Load/Current | Power Torque | Power Results

Monthly Operation Costs (30 Days per Month):

Run Time	8	hr/day
Cost With Gen. Credit	93.26	$
Cost No Gen. Credit	95.25	$
Demand Cost	38.41	$
Oil Prod. Cost	38.0	¢/bbl
Liquid Prod. Cost	7.3	¢/bbl
Oil Production	8.4	STB/D
Water Production	35	STB/D

Recommended Minimum NEMA D Motor	12.7	HP
Rated HP	30	HP
Rated Full Load AMPS	41.5	
Thermal AMPS	25.2	
Gross Input	9.3	HP
Net Input	9.1	HP
Demand	7.0	KW
Average	20.8	KVA



Average Power

With Generation Credit	6.8	KW
No Generation Credit	6.9	KW
Avg. Power Factor	30.4	%
System Efficiency	53.7	%

Stroke 2 | ? | < Pg Up | Pg Dwn >

Analysis And Workover Results

- Run time was reduced from 24 hours per day to 8 hours per day and the production increased slightly.
- Electricity bill was reduced from $201 per month to $94 per month.
- Expected equipment life was improved by a factor of 3.

Program to Calculate Pump Off Time and Max Off Time

1) Enter SPM & Pump Displacement for Initial Full Stroke
2) Enter Pump Displacement for one of last 5 Pump Off Stroke
3) Enter Tested Daily Water Production
4) Enter Seating Nipple Depth and Depth to Bottom of Perfs.

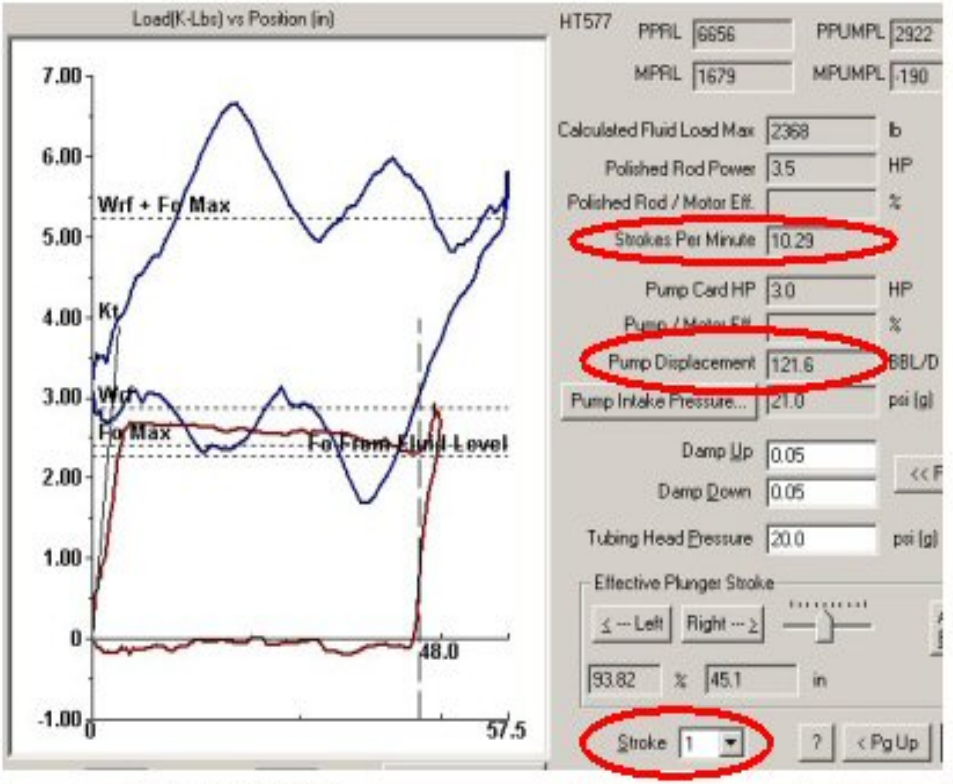
Assumes well under Pump off control with Pump SND below Perfs.
Initial Strokes must start up full and operate until the number of strokes to Pump Off occur. Then the POC shuts down welll for Max Off Time.

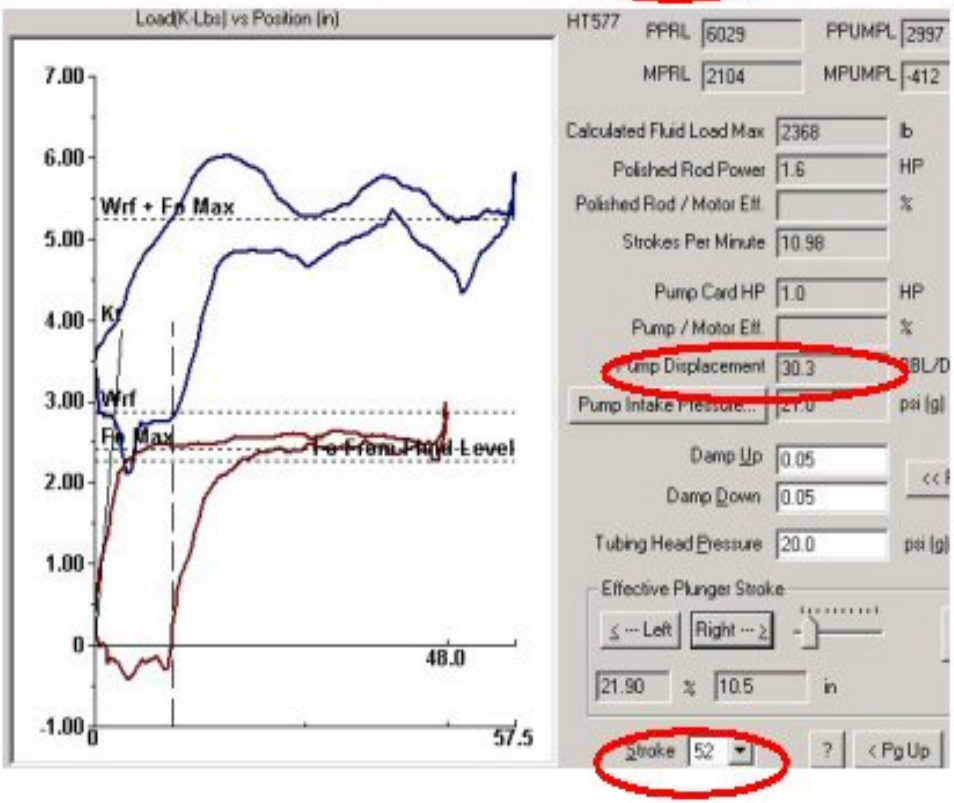
Initial Rate for Full Pump (BPD)	121.6
Final Pump Off Rate (BPD)	30.3
Initial Strokes Per Minute (SPM)	10.29
Daily Test Water Production (BPD)	50
SND: Seating Nipple Depth (Ft)	2947
Depth to Bottom of Perf (Ft)	2910

Tubing and Casing Size	2.375 x 4.5	2.375 x 5.0	2.375 x 5.5	2.375 x 7.0
Annular Capacity (BBLS/1000 Ft)	10.77	14.14	18.32	36.04
Pump Off Time - Minutes	8.01	10.52	13.63	26.82
Number of Strokes to Pump Off	82	108	140	276
Fill Up Rate - Ft/Min	3.224	2.456	1.895	0.963
Max Off Time / Cycle (Min)	11.48	15.07	19.52	38.41
Total Time Per Cycle (Min)	19.49	25.59	33.16	65.23
Number Cycles Per Day	73.88	56.28	43.43	22.08

Example: Swain 4 - 07/12/05

(((ECHOMETER)))

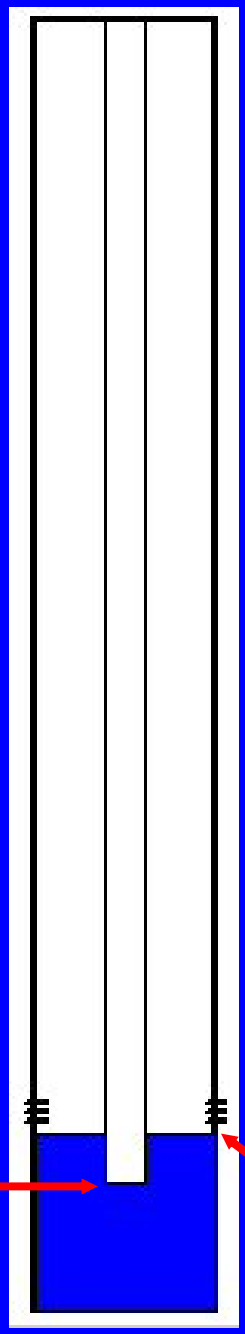




Calculate Pump Off Time and Max Off Time

Need to Know:

1. **SPM & Pump Displacement for Initial Full Stroke**
2. **Pump Displacement for one of last 5 Pump Off Stroke**
3. **Tested Daily Water Production**
4. **Seating Nipple Depth and Depth to Bottom of Perfs.**



Seating Nipple Depth

Depth to Bottom of Perfs

Assumes well under Pump off control with Pump SND below Perfs. Initial Strokes must start up full and operate until the number of strokes to Pump Off occur. Then the POC shuts down well for Max Off Time.

Excel Spreadsheet: Fillup_PumpOffRates.XLS

Questions?