

SROD v6.0 - PREDICTION OF ROD PUMPING SYSTEM PERFORMANCE

WELL NAME : 25m3d - 60% Fillage - 46% Efficiency - 7spm DATE/TIME : 12/16/2009 8:27:19 AM
 ANALYST : Jeff Wanner / Penta Completions COMPANY : TangentFlow
 DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical

**** PRIME MOVER ****

G.E. 40 HP KOF
 Speed Variation (%) : 11.9 Cyclic Load Factor : 1.903
 Power Required (hp) : 20.5 Motor Load (% of Rating) : 51.2
 Sheave Ratio (Unit/ Prime Mover) : 5.783

**** PUMPING UNIT ****

LUFKIN C456-256-144 WITH 94110B CRANKS (C'WISE)
 Actual Max Load (lbs) : 15229 Actual Min Load (lbs) : 5064
 Pumping Speed (spm) : 6.99 Max Load (% of Rating) : 59.5
 Polished Rod Power (hp) : 9.6 Computed Surface Stroke (cm) : 370.5

**** GEAR REDUCER ****

	<u>EXISTING</u>	<u>IN BALANCE</u>
Max Torque (m in-lbs)	414.5	398.6
Min Torque (m in-lbs)	-182.4	-174
Counterbalance (m in-lbs)	854.5	841.9
Effective Balance (X100 lbs)	120.8	119
Percent of Reducer Rating	90.9	87.4

**** ROD STRING ****

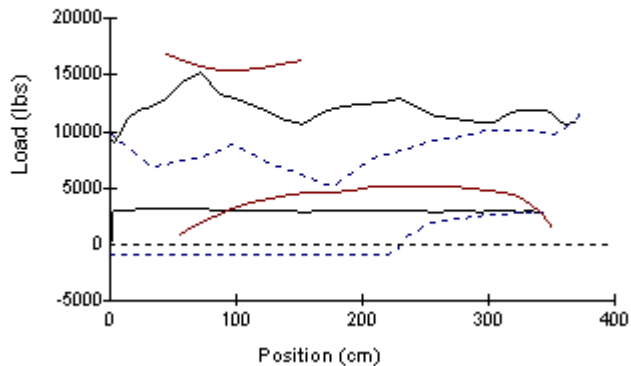
	<u>Diameter (mm)</u>	<u>Length (m)</u>	<u>Rod Type</u>	<u>Rod Loading</u>
1)	22.225	562	API D	91
2)	19.05	938	API D	84
Service Factor for Steel Rod	: 0.8			
Max Stress @ surface (MPa)	: 173		Min Stress @ surface (MPa)	: 59

**** DOWNHOLE PUMP ****

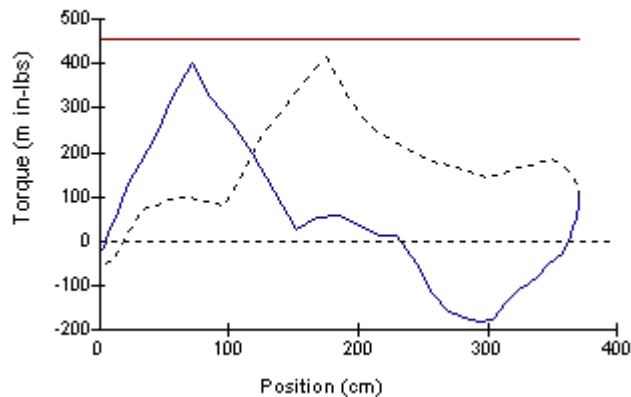
Bore Size (mm)	: 44.45	Setting Depth (m)	: 1500
Tubing Stretch (cm)	: 0	Lost Displacement (m ³ /d)	: 0
Pump Intake Pressure (kPa)	: 1689	Pump Spacing Guide (mm)	: 59
Tubing Size (mm)	: 73.025	Tubing Anchor Location (m)	: 1500
Tubing Gradient (kPa/m)	: 6.795	Pump Fillage (%)	: 60

	<u>Stroke (cm)</u>	<u>M³/D at 100% eff.</u>	<u>M³/D at 80% eff.</u>
Gross:	342.9	54 (24h/d)	43 (24h/d)
Net:	203.9	32 (24h/d)	25 (24h/d)

Dyno Surface and Pump Cards and Permissible Loads



Reducer Torque vs. Rod Position



SROD v6.0 - PREDICTION OF ROD PUMPING SYSTEM PERFORMANCE

**** Electric and Power Summary ****

WELL NAME : DATE/TIME : 12/16/2009 8:46:12 AM
 ANALYST : Jeff Wanner / Penta Completions COMPANY : TangentFlow
 DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical
 COMMENTS :

Prime Mover Description : G.E. 40 HP KOF
 Output of Motor (hp) : 10.7
 Input to Motor (true hp) : 13.8 Input to Motor (detent hp) : 16.4
 Peak Upstroke Amps : 58.4 Peak Downstroke Amps : 60
 Thermal Current (amps) : 32.9 Average Power Factor : 0.479
 Max Power Factor : 0.863 Min Power Factor : -0.643
 Continuous Demand (kw) : 10.3 Motor Load (% of rated amps) : 62.6
 Electrical CLF : 1.0585 Rated Voltage (volts) : 460
 KVA (kilovolt amps) : 21.5 Run Time (h/d) : 24

Cost Basis (\$/kwh)	Monthly Power Bills(\$)		Cost/[m ³ _day]/305m(\$)	
	Non-Detent	Detent	Non-Detent	Detent
.01	75	89	0.0181	.0216
.02	150	178	0.0363	.0431
.04	300	357	0.0725	.0862
.06	450	535	0.1088	.1293
.08	600	713	0.145	.1724
.10	750	892	0.1813	.2155
0.05	375	446	0.0144	.0171

Power costs do not include transformer and surface transmission line losses. Also, power factor penalty and demand charges, if any, are not considered. Lifting cost is based on net pump stroke and M³/day at 100% efficiency.

Fixed Capacitors for Power Factor Correction

Max Power Factor Desired	KVAR Required	Resulting Average Power Factor
0.863	0	0.479
0.892	3.2	0.55
0.921	6.7	0.646
0.95	10.6	0.779

Losses in Surface Unit and Drive Train (hp) : 1.1
 Polished Rod Power (hp) : 9.6
 Losses Along Rod String (hp) : 4
 Useful Downhole Pump Output (hp) : 5.6
 Surface Equipment Efficiency (%) : 69.8
 Overall System Efficiency (%) : 40.4

Caution: A good electrical power prediction requires a good prediction of polished rod power. Motor manufacturers may not always use the same rating criteria. Thus, electrical comparisons between different manufacturers should be used with caution.

SROD v6.0 - PREDICTION OF ROD PUMPING SYSTEM PERFORMANCE

WELL NAME : 25m3d - 70% Fillage - 57% Efficiency - 6spm DATE/TIME : 12/16/2009 8:47:01 AM
 ANALYST : Jeff Wanner / Penta Completions COMPANY : TangentFlow
 DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical

**** PRIME MOVER ****

G.E. 40 HP KOF
 Speed Variation (%) : 8.5 Cyclic Load Factor : 1.695
 Power Required (hp) : 16 Motor Load (% of Rating) : 40
 Sheave Ratio (Unit/ Prime Mover) : 6.796

**** PUMPING UNIT ****

LUFKIN C456-256-144 WITH 94110B CRANKS (C'WISE)
 Actual Max Load (lbs) : 14628 Actual Min Load (lbs) : 5106
 Pumping Speed (spm) : 5.98 Max Load (% of Rating) : 57.1
 Polished Rod Power (hp) : 8.4 Computed Surface Stroke (cm) : 370.5

**** GEAR REDUCER ****

	<u>EXISTING</u>	<u>IN BALANCE</u>
Max Torque (m in-lbs)	401.6	395.5
Min Torque (m in-lbs)	-100.5	-105
Counterbalance (m in-lbs)	802.7	806.3
Effective Balance (X100 lbs)	113.3	113.8
Percent of Reducer Rating	88.1	86.7

**** ROD STRING ****

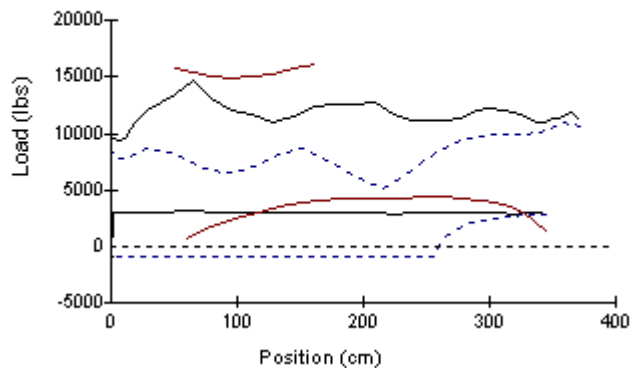
	<u>Diameter (mm)</u>	<u>Length (m)</u>	<u>Rod Type</u>	<u>Rod Loading</u>
1)	22.225	562	API D	85
2)	19.05	938	API D	80
Service Factor for Steel Rod	: 0.8			
Max Stress @ surface (MPa)	: 167		Min Stress @ surface (MPa)	: 60

**** DOWNHOLE PUMP ****

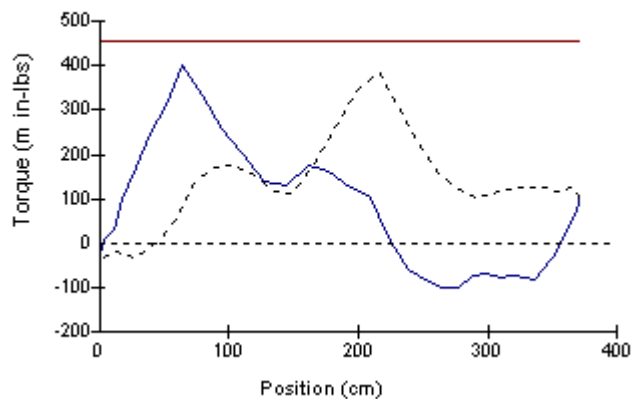
Bore Size (mm) : 44.45 Setting Depth (m) : 1500
 Tubing Stretch (cm) : 0 Lost Displacement (m³/d) : 0
 Pump Intake Pressure (kPa) : 1689 Pump Spacing Guide (mm) : 46
 Tubing Size (mm) : 73.025 Tubing Anchor Location (m) : 1500
 Tubing Gradient (kPa/m) : 6.795 Pump Fillage (%) : 70

	<u>Stroke (cm)</u>	<u>M³/D at 100% eff.</u>	<u>M³/D at 80% eff.</u>
Gross:	344.1	46 (24h/d)	37 (24h/d)
Net:	239.5	32 (24h/d)	26 (24h/d)

Dyno Surface and Pump Cards and Permissible Loads



Reducer Torque vs. Rod Position



SROD v6.0 - PREDICTION OF ROD PUMPING SYSTEM PERFORMANCE

**** Electric and Power Summary ****

WELL NAME : DATE/TIME : 12/16/2009 8:47:28 AM
 ANALYST : Jeff Wanner / Penta Completions COMPANY : TangentFlow
 DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical
 COMMENTS :

Prime Mover Description : G.E. 40 HP KOF
 Output of Motor (hp) : 9.4
 Input to Motor (true hp) : 11.6 Input to Motor (detent hp) : 13.1
 Peak Upstroke Amps : 50.3 Peak Downstroke Amps : 50.1
 Thermal Current (amps) : 29.3 Average Power Factor : 0.422
 Max Power Factor : 0.847 Min Power Factor : -0.358
 Continuous Demand (kw) : 8.6 Motor Load (% of rated amps) : 55.7
 Electrical CLF : 1.0386 Rated Voltage (volts) : 460
 KVA (kilovolt amps) : 20.4 Run Time (h/d) : 24

Cost Basis (\$/kwh)	Monthly Power Bills(\$)		Cost/[m ³ _day]/305m(\$)	
	Non-Detent	Detent	Non-Detent	Detent
.01	63	71	0.0151	.0171
.02	126	142	0.0303	.0342
.04	252	284	0.0606	.0684
.06	377	426	0.0908	.1026
.08	503	569	0.1211	.1368
.10	629	711	0.1514	.1710
0.05	315	355	0.012	.0136

Power costs do not include transformer and surface transmission line losses. Also, power factor penalty and demand charges, if any, are not considered. Lifting cost is based on net pump stroke and M³/day at 100% efficiency.

Fixed Capacitors for Power Factor Correction

Max Power Factor Desired	KVAR Required	Resulting Average Power Factor
0.847	0	0.422
0.881	3.1	0.488
0.916	6.4	0.579
0.95	10.1	0.716

Losses in Surface Unit and Drive Train (hp) : 0.9
 Polished Rod Power (hp) : 8.4
 Losses Along Rod String (hp) : 3.1
 Useful Downhole Pump Output (hp) : 5.3
 Surface Equipment Efficiency (%) : 72.8
 Overall System Efficiency (%) : 45.6

Caution: A good electrical power prediction requires a good prediction of polished rod power. Motor manufacturers may not always use the same rating criteria. Thus, electrical comparisons between different manufacturers should be used with caution.

SROD v6.0 - PREDICTION OF ROD PUMPING SYSTEM PERFORMANCE

WELL NAME : 25m3d - 85% Fillage - 68% Efficiency - 5spm DATE/TIME : 12/16/2009 8:47:56 AM
 ANALYST : Jeff Wanner / Penta Completions COMPANY : TangentFlow
 DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical

**** PRIME MOVER ****

G.E. 40 HP KOF
 Speed Variation (%) : 7.3 Cyclic Load Factor : 1.661
 Power Required (hp) : 13.7 Motor Load (% of Rating) : 34.2
 Sheave Ratio (Unit/ Prime Mover) : 8.145

**** PUMPING UNIT ****

LUFKIN C456-256-144 WITH 94110B CRANKS (C'WISE)
 Actual Max Load (lbs) : 14222 Actual Min Load (lbs) : 5483
 Pumping Speed (spm) : 5 Max Load (% of Rating) : 55.6
 Polished Rod Power (hp) : 7.3 Computed Surface Stroke (cm) : 370.5

**** GEAR REDUCER ****

	<u>EXISTING</u>	<u>IN BALANCE</u>
Max Torque (m in-lbs)	381.3	368
Min Torque (m in-lbs)	-116.9	-108.1
Counterbalance (m in-lbs)	807.1	796.1
Effective Balance (X100 lbs)	113.9	112.3
Percent of Reducer Rating	83.6	80.7

**** ROD STRING ****

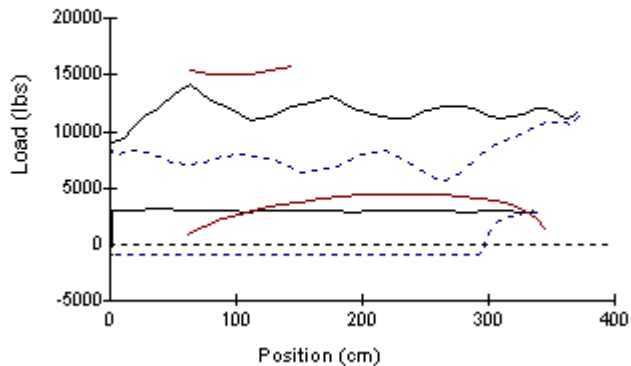
	<u>Diameter (mm)</u>	<u>Length (m)</u>	<u>Rod Type</u>	<u>Rod Loading</u>
1)	22.225	562	API D	79
2)	19.05	938	API D	76
Service Factor for Steel Rod	: 0.8			
Max Stress @ surface (MPa)	: 162		Min Stress @ surface (MPa)	: 64

**** DOWNHOLE PUMP ****

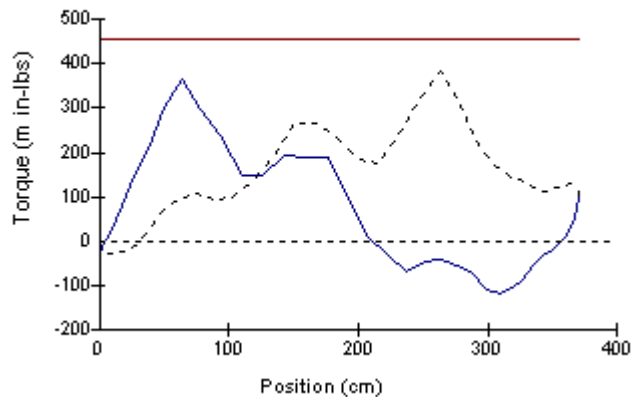
Bore Size (mm)	: 44.45	Setting Depth (m)	: 1500
Tubing Stretch (cm)	: 0	Lost Displacement (m³/d)	: 0
Pump Intake Pressure (kPa)	: 1689	Pump Spacing Guide (mm)	: 19
Tubing Size (mm)	: 73.025	Tubing Anchor Location (m)	: 1500
Tubing Gradient (kPa/m)	: 6.795	Pump Fillage (%)	: 85

	<u>Stroke (cm)</u>	<u>M³/D at 100% eff.</u>	<u>M³/D at 80% eff.</u>
Gross:	337.9	38 (24h/d)	30 (24h/d)
Net:	286.3	32 (24h/d)	26 (24h/d)

Dyno Surface and Pump Cards and Permissible Loads



Reducer Torque vs. Rod Position



SROD v6.0 - PREDICTION OF ROD PUMPING SYSTEM PERFORMANCE

**** Electric and Power Summary ****

WELL NAME : DATE/TIME : 12/16/2009 8:48:18 AM
 ANALYST : Jeff Wanner / Penta Completions COMPANY : TangentFlow
 DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical
 COMMENTS :

Prime Mover Description : G.E. 40 HP KOF
 Output of Motor (hp) : 8.1
 Input to Motor (true hp) : 9.9 Input to Motor (detent hp) : 11.1
 Peak Upstroke Amps : 43.1 Peak Downstroke Amps : 43.5
 Thermal Current (amps) : 27.4 Average Power Factor : 0.373
 Max Power Factor : 0.803 Min Power Factor : -0.34
 Continuous Demand (kw) : 7.4 Motor Load (% of rated amps) : 52.1
 Electrical CLF : 1.0236 Rated Voltage (volts) : 460
 KVA (kilovolt amps) : 19.7 Run Time (h/d) : 24

Cost Basis (\$/kwh)	Monthly Power Bills(\$)		Cost/[m ³ _day]/305m(\$)	
	Non-Detent	Detent	Non-Detent	Detent
.01	54	60	0.0129	.0145
.02	107	121	0.0258	.0291
.04	215	242	0.0516	.0581
.06	322	362	0.0774	.0872
.08	429	483	0.1032	.1163
.10	536	604	0.1291	.1453
0.05	268	302	0.0103	.0116

Power costs do not include transformer and surface transmission line losses. Also, power factor penalty and demand charges, if any, are not considered. Lifting cost is based on net pump stroke and M³/day at 100% efficiency.

Fixed Capacitors for Power Factor Correction

Max Power Factor Desired	KVAR Required	Resulting Average Power Factor
0.803	0	0.373
0.852	3.6	0.446
0.901	7.3	0.554
0.95	11.5	0.735

Losses in Surface Unit and Drive Train (hp) : 0.8
 Polished Rod Power (hp) : 7.3
 Losses Along Rod String (hp) : 2.4
 Useful Downhole Pump Output (hp) : 4.9
 Surface Equipment Efficiency (%) : 74.3
 Overall System Efficiency (%) : 50.1

Caution: A good electrical power prediction requires a good prediction of polished rod power. Motor manufacturers may not always use the same rating criteria. Thus, electrical comparisons between different manufacturers should be used with caution.

Well Cost Summary with Q2 Flow using SROD Report and 25 % increase in pump Efficiency

WELL NAME : 25m3d - 60% Fillage - 46% Efficiency - 7spm DATE/TIME : 12/16/2009 8:27:19 AM
DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical

Monthly Power Bills = \$ 446 Before

WELL NAME : 25m3d - 70% Fillage - 57% Efficiency - 6spm DATE/TIME : 12/16/2009 8:47:01 AM
DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical

Monthly Power Bills = \$ 355 After

WELL NAME : 25m3d - 85% Fillage - 68% Efficiency - 5spm DATE/TIME : 12/16/2009 8:47:56 AM
DATA FILE : Example 1.inp6 (BASE CASE) WELL TYPE : Vertical

Monthly Power Bills = \$ 302 After

AT 25 % Efficiency

Monthly Power Bills = \$ 329 After Average

Savings with Q2 Flow Cage = \$ 118 /mntn per well

Efficiency

0.142857 70 60

0.294118 85 60

0.25 80 60