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SUCKER ROD STRING DESIGN CALCULATION
INPUT DATA

Company _____ Fax _____
Representative _____ Phone _____
Location & Field _____

WELL DATA:

Pump Depth (Ft./M) _____T.D. _____ Perforations _____

Fluid Level (Ft./M) _____From Surface or Pump Intake Pressure _____

Tubing Size (in./mm) _____ Anchored _____ Depth _____

Pumping Unit API _____ - _____ - _____ Mfgr. _____ cw/ccw _____

Prime Mover: Electric _____ HP Type _____ Reg./Hi-slip; Gas _____ HP

Plgr. Dia. (in./mm) _____ Stroke Used (in./cm) _____ S.P.M. _____

Production (BFPD/Cu.M/day) Current _____ Target _____

Oil _____/day API Gravity _____; Water _____/day Specific Gravity _____

Actual Sp. Gr. of Fluid _____ Water Cut _____ % GOR _____ (Cu.M/CF/B)

Pressure: Flowline (PSI/Kpa) _____ Casing (PSI/Kpa) _____

ROD STRING: (From Surface)

Rod Size (in./mm)	Length Ft./M	Steel F.Glass	Grade	Guided Wheeled Cplgs.
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Well/Fluid Characteristics:

Producing Formation _____ Type (Sand; Shale; Limestone) _____
Corrosive (H2S; CO2; Water; Brine) _____
Known Well Problems _____
Deviated _____ (If so Deviation Surveys Available _____)
Dynamometer Reports Available? _____

PRODUCTION CALCULATION FORMULAS

PRODUCTION (B.F.P.D) = P.C. X SPM X DOWNHOLE PUMP STROKE

PUMP SIZE	PUMP CONSTANTS	FLUID LOAD CPNSTANTS
1 1/16" (27mm)	0.132	0.384
1 1/4" (31.8 mm)	0.182	0.531
1 1/2" (38.1 mm)	0.262	0.765
1 3/4" (44.5 mm)	0.357	1.041
2.0" (50.8mm)	0.466	1.360
2 1/4" (57.2 mm)	0.590	1.721
2 1/2" (63.5 mm)	0.729	2.125
2 3/4" (69.9 mm)	0.881	2.571
3 1/4" (82.6 mm)	1.231	3.590
3 3/4" (95.6 mm)	1.639	4.780
4 3/4" (120.7 mm)	2.630	7.670
5 3/4" (146.1 mm)	3.855	11.240
7 3/4" (196.9 mm)	7.00	20.420

PUMP CONSTANT = PLUNGER DIAMETER 2 X .1166

FLUID LEVEL LOAD CONSTANTS = WT. OF FLUID ON PLUNGER (Lb./Ft)

FLUID LOAD FORMULA

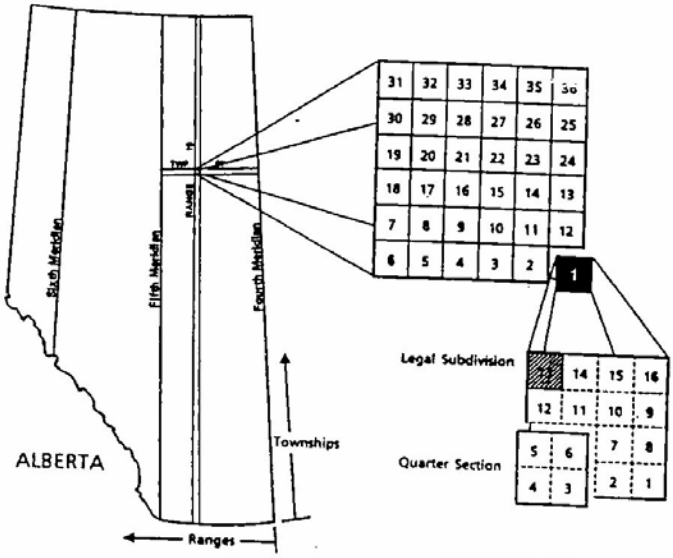
FLUID LOAD = F.L.C X NET LIFT (IN FEET) X SPECIFIC GRAVITY

FLUID LOAD CONSTANT = (PLUNGER DIAMETER 2 X .340

WESTERN CANADA SURVEY SYSTEMS

ALBERTA, SASKATCHEWAN, MANITOBA

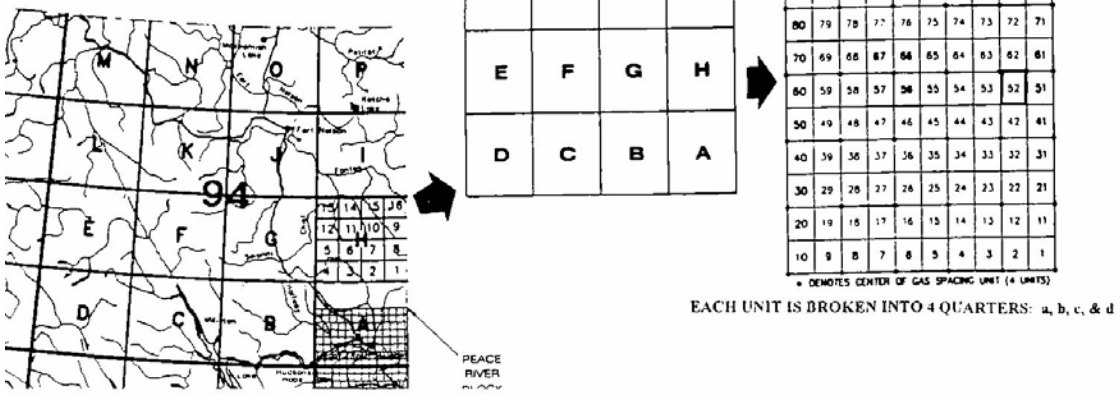
The prairie provinces are divided into areas separated by north-south meridians, starting with the first meridian which passes through Winnipeg. Townships are numbered from the Canada-US border (1) and increase to the north.
Legal description shown is 13-01-087-18 W/4M



BRITISH COLUMBIA

94 – H – 16 –H -b

94 – MAP	H – UNIT
16 – SHEET	H – ZONE
52 – CENTIZONE	b – UNIT



EACH UNIT IS BROKEN INTO 4 QUARTERS: a, b, c, & d

ROD DIMENSIONS

ROD SIZE	PIN SHOULDER - OD	WRENCH WIDTH	FLAT LENGTH	BEAD - OD
5/8 (15.9)	1.25 (31.8)	0.8750 (22.2)	1.25 (31.8)	1.2187 (31.1)
3/4 (19.0)	1.50 (38.1)	1.0 (25.4)	1.25 (31.8)	1.4062 (35.7)
7/8 (22.2)	1.625 (41.3)	1.0 (25.4)	1.25 (31.8)	1.500 (38.1)
1.0 (25.4)	2.00 (50.8)	1.3125 (33.3)	1.50 (38.1)	1.9062 (48.4)
1 1/8 (28.6)	2.25 (57.2)	1.500 (38.1)	1.6250 (41.3)	1.1875 (55.6)

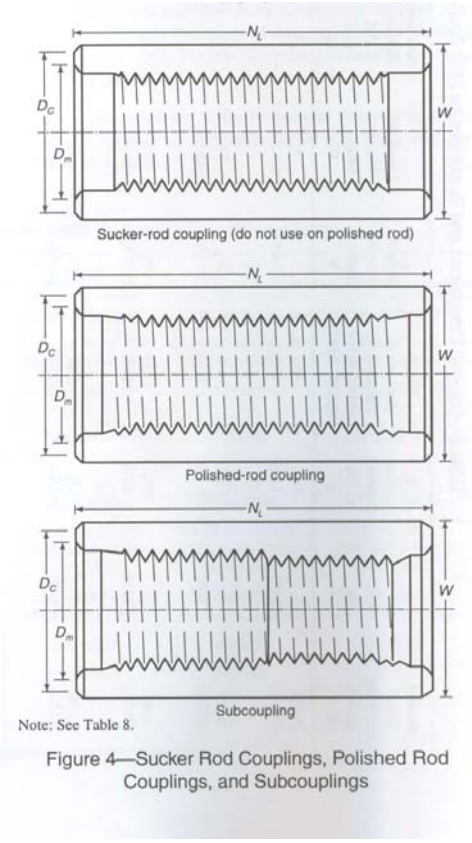
All DIMENSIONS IN INCHES (mm)

COUPLING DIMENSIONS

NOMINAL COUPLING SIZE	OUTSIDE DIAMETER (W) + 0.005 (+0.13) -0.0010 (-0.25)	LENGTH (NL) +0.062 (+1.57) -0.000 (-0.00)
5/8 (15.9) S.H.	1.250 (31.8)	4.00 (101.6)
5/8 (15.9)	1.500 (38.1)	4.00 (101.6)
3/4 (19.1) S.H.	1.500 (38.1)	4.00 (101.6)
3/4 (19.1)	1.625 (41.3)	4.00 (101.6)
7/8 (22.2) S.H.	1.625 (41.3)	4.00 (101.6)
7/8 (22.2)	1.812 (46.0)	4.00 (101.6)
1.0 (25.4) S.H.	2.000 (50.8)	4.00 (101.6)
1.0 (25.4)	2.187 (55.6)	4.00 (101.6)
1 1/8 (28.6)	2.375 (60.3)	4.500 (114.3)
1 1/8 (28.6) S.H.	2.1875 (55.6)	4.500 (114.3)

Size of coupling is same as corresponding sucker rod size. S.H. is reduced outside diameter coupling known as slim hole.
(W) Outside diameter shall conform to the layer box thread.

ALL DIMENSIONS IN INCHES (MM)



Note: See Table 8.

Figure 4—Sucker Rod Couplings, Polished Rod Couplings, and Subcouplings

SHIPPING WEIGHTS

ROD SIZE	WT./FT (Kg/m)	WT/ROD – LB(Kg)	60 RODS	80 RODS	100 RODS
5/8 (15.9)	1.135 (1.7)	28 (12.7)	1680 (762)	-	2800 (1270)
3/4 (19.0)	1.634 (2.4)	41 (18.6)	2460 (1116)	-	4100 (1860)
7/8 (22.0)	2.224 (3.3)	56 (25.4)	3360 (1524)	4480 (2032)	-
1.0 (25.4)	2.904 (4.3)	73 (33.1)	4380 (1987)	-	-
1 1/8 (28.6)	3.676 (5.5)	92 (41.7)	5520 (2504)	-	-
ADD TO ROD WEIGHT					
2” RYTON	0.27	6.75 (3.06)	405 (184)		675 (306)
SCRAPPERS 6/RODS					
2 1/2" RYTON	0.37	9.25 (4.19)	555 (252)		925 (420)
SCRAPPERS 6/RODS					

TUBING FACTS

FLUID CAPACITIES TUBING					
TUBING SIZE	WEIGHT	BBL/FT	FT/BBL	Cu.M/M	M/Cu.M
2 3/8” (60 mm)	4.7 #/Ft.	0.00387	258.4	0.0020	495.47
	6.99 Kg./M				
2 7/8’ (73 mm)	6.5 #/Ft.	0.00579	212.8	0.0025	406.5
	9.67 Kg./M				
3 1/2” (89 mm)	9.3 #/Ft.	0.0076	131.6	0.004	251.3
	13.84 Kg./M				

ANNULAR VOLUME BETWEEN TUBING & CASING

TUBING	CASING	BBL/FT	FT/BBL	Cu.M/M	M/Cu.M
2 3/8” (60 mm)	4 1/2” (114 mm)	0.0108	92.59	0.0056	177.93
	5 1/2" (140 mm)	0.0189	52.91	0.0099	101.32
	7” (178 mm)	0.0360	27.78	0.0188	53.19
2 7/8’ (73 mm)	4 1/2” (114 mm)	0.0082	121.95	0.0043	233.1
	5 1/2" (140 mm)	0.0165	60.98	0.0085	117.10
	7” (178 mm)	0.0325	30.77	0.0169	59.07
3 1/2” (89 mm)	5 1/2" (140 mm)	0.0103	97.09	0.0054	186.57
	7” (178 mm)	0.0286	34.97	0.0149	67.07

SUCKER ROD DISPLACEMENT

ROD SIZE	ROD WEIGHT	WEIGHT/ROD	BBL/1,000 Ft.	Cu. M/1,000 M
5/8” (15.9 mm)	1.14 #/Ft.	28.5 # (12.9 Kg)	0.4	0.2
3/4” (19 mm)	1.63 #/Ft.	40.3 # (18.8 Kg)	0.6	0.3
7/8” (22 mm)	2.22 #/Ft.	54.5 # (24.7 Kg)	0.8	0.4
1.0” (25.4 mm)	2.90 #/Ft.	72.3 # (32.7 Kg)	1.0	0.5

BOUYANT ROD WEIGHT: ROD WEIGHT IN AIR X .875 (STEEL RODS) X .55 (FG RODS)

TUBING DRIFT AND API PUMP SEATING NIPPLE I.D.

TUBING SIZE	DRIFT	API PSN ID
1.900” (48.3 mm)	1.561” (39.65 mm)	1.460” (37.08 mm)
2 1/16” (52.39 mm)	1.657” (42.09 mm)	1.540” (39.12 mm)
2 3/8” (60 mm)	1.901” (48.29 mm)	1.780” (45.21 mm)
2 7/8” (73 mm)	2.347” (59.61 mm)	2.280” (57.91 mm)
3 ½” (88.9 mm)	2.867” (72.82 mm)	2.780” (70.61 mm)

PRODUCTION CALCULATION FORMULAS

I WELL PRODUCTION "BPD"

$$P = K \times Sp \times SPM$$

Where P = Production (barrels per day)
K = Pump plunger constant
Sp = Plunger stroke (inches)
SPM = Strokes per minute

Then actual production = Theoretical Displacement x Pump Volumetric Efficiency.

II FLUID LOAD "FL"

FL = F.L. "K" X Net Lift (In Feet) X Specific Gravity

Where K = Fluid Load Constant (See Table VII)
(Plunger Diameter) 2 X .340

III ROD STRETCH "E"

$$E = Ec\ (D/1000)2$$

Where E = Combined rod and tubing stretch (inches)
Ec = Stretch coefficient
D = Depth of pump (feet)

Where Cr = Stretch coefficient of rods
Ct = Stretch coefficient of tubing
(Not required if tubing is anchored near pump)

and $Cr = \frac{(.136)\ (d)}{Ar}$ (See Table III)

Where D = Plunger diameter (inches)
Ar = Cross-sectional area of rods (square inches)
(See Table I)

and $Ct = \frac{(.136)\ (d)}{At}$ (See Table IV)
At Where At = Cross - sectional area of tubing (square inches) (See Table VI)

For tapered rod string use the coefficients for different rod sizes X length of section.

ei. $Crt = \frac{C1L1 + C2L2 + C3L3}{D}$

IV PLUNGER OVER TRAVEL "O"

$$O = 1.55\ (F - 1)\ (D/1000)2$$

Where O = Overtravel (inches)
F = Impulse factor
D = Depth of pump (feet)

And $F = 1 + \frac{S \times SPM\ 2}{70{,}500}$ (See Table V)

Where S = Polish rod stroke (inches)
SPM = Strokes per minute

V PLUNGER STROKE "Sp"

$$Sp = S - E + O$$

Where Sp = Plunger stroke (inches)
S = Polish rod stroke (inches)
E = Combined rod and tubing stretch (inches)
O = Plunger overtravel (inches)

VI STATIC ROD WEIGHT IN AIR "Wra"

Wra = (Wt. per foot) X (Pump Depth)

VII EFFECTIVE WEIGHT OF RODS "EWr" (Buoyant weight of Rods)

EWr = (0.875) X (Wra)

VIII WEIGHT OF FLUID "Wf"

Wf = (Wt. per foot on plunger) X (Depth)

IX PEAK POLISH ROD LOAD "PPRL"

PPRL = (Wf + EWr) - F
F = Impulse factor

X ROD STRESS "Sr"

Straight Rod String - Sr

$$Sr = \frac{PPRL}{Ar}$$

Tapered Rod String - Sr1, Sr2, Sr3

$$Sr1 = \frac{PPRL}{Ar1} \qquad Sr2 = \frac{Wf + F\ (Wr2+Wr3)}{Ar2} \qquad Sr3 = \frac{Wf + F\ (Wr3)}{Ar3}$$

XI MINIMUM POLISH ROD LOAD "MPRL"

MPRL = Wr (1.87 - F)
F = Impulse Factor

XII PEAK TORQUE "PT"

PT = 0.2 x PPRL X S
S= Polish rod stroke in inches

XIII COUNTERBALANCE "CB"

CB = (0.5 X FLUID LOAD) + (Wt. OF RODS IN AIR)

XIV HORSEPOWER "HP"

For High Slip Electric and Single Cylinder Gas

$$HP = \frac{BPD \ X \ Depth}{56{,}000}$$

For Normal Slip Electric and Multi-Cylinder Gas

$$HP = \frac{BPD \ X \ Depth}{45{,}000}$$

XV STROKES PER MINUTE "SPM"

$$SPM = \frac{RPM}{R} \ X \ \frac{d}{D}$$

Where R = Ratio of Gear Reducer
d = Diameter of Prime Mover Sheave
D = Diameter of Unit Sheave
RPM = Prime Mover Speed

XVI SHEAVE SIZING

$$d = \frac{SPM \ X \ R \ X \ D}{RPM}$$

Where R = Ratio of Gear Reducer
d = Diameter of Prime Mover Sheave
D = Diameter of Unit Sheave
RPM = Prime Mover Speed

SHEAVE SIZING WITH JACKSHAFT

$$RPM \times \frac{d1}{d2} \times \frac{d3}{D} \times \frac{1}{GB\ Ratio}$$

d1 – engine sheave
d2 – Jack shaft in
d3 – Jack Shaft out
D – Pump Jack Sheave

XVII BELT LENGTH

BL = 2 X CD + 1.57(D+d)

Where d = Diameter of Prime Mover Sheave
D = Diameter of Unit Sheave
CD = Centre Distance of Shafts
BL = Belt Length in inches

XVII PUMP INTAKE PRESSURE "PIP"

1) Multiply percent of oil times the specific gravity of the oil (See Table VIII)
2) Multiply percent of water times the specific gravity of the water (See Table VIII)
3) Add the two totals to get the specific gravity of fluid
4) Multiply specific gravity of fluid times .433 to get tubing gradient
5) Multiply tubing gradient times feet of total fluid above BH Pump

Ei: 90% API 4l Oil
10% 1.17 Water
2000' Fluid over pump

.90 X .820 = .7382
.10 X 1.17 = .1170
Total Sp. Gr. .8552
.433 X .8552 = .37 Tubing Gradient
.37 X 2,000 = 740 PSI Pump Intake Pressure

IXX GAS/OIL RATIO "GOR"

METRIC TO ENGLISH CONVERSION

180 m3m3 = 1000 Cu.Ft. per bbl

1 m3m3	=	5.56 cu.ft./bbl
50 m3m3	=	278 cu.ft./bbl
100 m3m3	=	556 cu.ft./bbl
150 m3m3	=	834 cu.ft./bbl
180 m3m3	=	1000 cu.ft./bbl
200 m3m3	=	1112 cu.ft./bbl
250 m3m3	=	1390 cu.ft./bbl
300 m3m3	=	1668 cu.ft./bbl
350 m3m3	=	1946 cu.ft./bbl
400 m3m3	=	2224 cu.ft./bbl
450 m3m3	=	2502 cu.ft./bbl
500 m3m3	=	2780 cu.ft./bbl
550 m3m3	=	3058 cu.ft./bbl
600 m3m3	=	3336 cu.ft./bbl
650 m3m3	=	3614 cu.ft./bbl
700 m3m3	=	3892 cu.ft./bbl
750 m3m3	=	4170 cu.ft./bbl
800 m3m3	=	4448 cu.ft./bbl
850 m3m3	=	4726 cu.ft./bbl
900 m3m3	=	5004 cu.ft./bbl
950 m3m3	=	5282 cu.ft./bbl
1000 m3m3	=	5560 cu.ft./bbl

SUBSURFACE PUMP DATA

TABLE I

PLUNGER SIZE	PLUNGER CONSTANT "K"	WT. OF FLUID PER FOOT ON PLUNGER	AREA SQ. IN.
3/4"	.066	.191 #/ft.	.442
7/8"	.089	.260 #/ft.	.601
1"	.117	.340 #/ft.	.785
1-1/16"	.132	.383 #/ft.	.887
1-1/4"	.182	.531 #/ft.	1.227
1-1/2"	.262	.765 #/ft.	1.767
1-5/8"	.308	.900 #/ft.	2.074
1-3/4"	.357	1.040 #/ft.	2.405
1-25/34"	.370	1.070 #/ft.	2.493
2"	.466	1.360 #/ft.	3.142
2-1/8"	.526	1.535 #/ft.	3.547
2-1/4"	.590	1.720 #/ft.	3.976
2-1/2"	.729	2.120 #/ft.	4.909
2-3/4"	.881	2.570 #/ft.	5.940
3-1/4"	1.231	3.590 #/ft.	8.296
3-3/4"	1.639	4.780 #/ft.	11.045
4-3/4"	2.630	7.690 #/ft.	17.721

PERCENTAGES FOR TAPERED ROD STRINGS*

TABLE II

PLUNGER DIAMETER	THREE COMBINATIONS				TWO COMBINATIONS		
	1" - 7/8" - 3/4"		7/8" - 3/4" - 5/8"		1" - 7/8"	7/8" - 3/4"	3/4" - 5/8"
	% 3/4"	% 7/8"	% 5/8"	% 3/4"	% 7/8"	% 3/4"	% 5/8"
1-1/16"	58.8	21.9	51.3	26.1	77.7	74.1	68.7
1-1/4"	55.8	23.5	46.6	28.6	76.5	72.2	65.6
1-1/2"	51.0	26.0	39.1	32.6	74.5	69.1	60.8
1-5/8"	48.3	27.4	34.9	34.9	73.3	67.5	58.4
1-3/4"	45.4	29.0	30.2	37.4	72.1	65.7	55.0
1-25/32"	44.6	29.4	29.1	38.0	71.8	65.1	54.7
2"	38.8	32.5	20.0	42.8	69.4	61.5	48.4
2-1/8"	34.4	35.3	14.5	45.9	67.9	59.3	45.3
2-1/4"	31.4	36.5	8.3	49.2	66.3	56.9	41.0
2-1/2"	22.6	41.6	-	-	62.8	51.7	32.6
2-3/4"	14.1	45.6	-	-	59.0	45.9	23.4
3-1/4"	-	-	-	-	50.3	32.8	-
3-3/4"	-	-	-	-	40.0	17.5	-

* Based on equal stress at top of each section pf rods under static loading. For Additional combinations see API RPIL

TABLE III - COEFFICIENT OF SUCKER ROD STRETCH, Cr

ROD SIZE	PLUNGER DIAMETER													
	3/4”	7/8”	1”	1-1/16”	1-1/4”	1-1/2”	1-3/4”	1-25/32”	2”	2-1/4”	2-1/2”	2-3/4”	3-1/4”	3-3/4”
1/2"	0.39	0.53	0.69	0.78	-	-	-	-	-	-	-	-	-	-
5/8”	0.25	0.34	0.44	0.50	0.69	1.00	1.36	1.41	1.77	2.24	2.77	3.35	4.68	6.23
3/4"	0.17	0.24	0.31	0.35	0.48	0.69	0.94	0.98	1.23	1.56	1.92	2.32	3.25	4.33
7/8”	0.13	0.17	0.23	0.25	0.35	0.51	0.69	0.72	0.91	1.14	1.41	1.71	2.39	3.18
1”	-	-	-	0.20	0.27	0.39	0.53	0.55	0.69	0.88	1.08	1.31	1.83	2.44
1-1/8”	-	-	-	0.16	0.21	0.31	0.42	0.44	0.55	0.70	0.85	1.04	1.45	1.93

TABLE IV - COEFFICIENT OF TUBING STRETCH Ct

PLUNGER DIAMETER	TUBING DIAMETER							
	1-1/4”	1-1/2”	1-3/4”	2”	2-1/2”	3”	3-1/2”	4”
3/4"	0.11	0.09	0.08	0.05	0.04	-	-	-
7/8”	0.16	0.13	0.11	0.08	0.06	0.04	-	-
1”	0.20	0.17	0.15	0.10	0.07	0.05	0.04	-
1-1/16”	0.23	0.19	0.16	0.12	0.08	0.06	0.05	0.04
1-1/4”	-	0.27	0.22	0.16	0.12	0.08	0.08	0.06
1-1/2”	-	-	0.33	0.24	0.17	0.12	0.11	0.08
1-3/4”	-	-	-	0.32	0.23	0.16	0.15	0.11
1-25/32	-	-	-	0.33	0.24	0.17	0.16	0.12
2”	-	-	-	0.42	0.30	0.21	0.20	0.15
2-1/4”	-	-	-	0.53	0.38	0.27	0.26	0.19
2-1/2”	-	-	-	-	0.47	0.33	0.32	0.24
2-3/4”	-	-	-	-	0.57	0.40	0.39	0.28
3-1/4”	-	-	-	-	-	0.55	0.54	0.40
3-3/4”	-	-	-	-	-	-	0.72	0.53

TABLE V – IMPULSE FACTOR F

LENGTH POLISHED ROD STROKE(S) IN INCHES

$$F = 1 + \frac{S \times SPM^2}{70{,}500}$$

SPM	24	25	28	32	34	37	38	40	42	44	47	48	54	56	60	64	66	73	74	75	76	78	86	100	103	106	120	144
6	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.06	1.07
7	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.05	1.05	1.06	1.07	1.07	1.07	1.08	1.10
8	1.02	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.13
9	1.03	1.03	1.03	1.04	1.04	1.04	1.04	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.09	1.09	1.10	1.12	1.12	1.12	1.14	1.16
10	1.03	1.04	1.04	1.05	1.05	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.09	1.10	1.10	1.10	1.11	1.11	1.12	1.14	1.15	1.15	1.17	1.20
11	1.04	1.04	1.05	1.05	1.05	1.06	1.07	1.07	1.07	1.08	1.08	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.13	1.13	1.13	1.13	1.15	1.17	1.18	1.18	1.20	1.24
12	1.05	1.05	1.06	1.07	1.07	1.08	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.11	1.12	1.13	1.13	1.15	1.15	1.15	1.16	1.16	1.18	1.20	1.21	1.22	1.25	1.29
13	1.06	1.06	1.07	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.18	1.18	1.18	1.19	1.20	1.24	1.25	1.25	1.29	1.33
14	1.07	1.07	1.08	1.09	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.13	1.15	1.16	1.17	1.18	1.18	1.20	1.21	1.21	1.21	1.22	1.24	1.27	1.29	1.30	1.33	1.40
15	1.08	1.08	1.09	1.10	1.10	1.12	1.12	1.13	1.13	1.14	1.15	1.15	1.17	1.19	1.19	1.20	1.21	1.23	1.24	1.24	1.24	1.25	1.27	1.32	1.33	1.34	1.39	1.46
16	1.09	1.09	1.10	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.17	1.20	1.20	1.22	1.23	1.24	1.27	1.27	1.27	1.28	1.28	1.31	1.36	1.38	1.38	1.44	1.52
17	1.10	1.10	1.11	1.13	1.13	1.15	1.16	1.16	1.17	1.18	1.19	1.20	1.22	1.23	1.25	1.26	1.27	1.30	1.30	1.31	1.32	1.32	1.35	1.41	1.42	1.43	1.49	1.59
18	1.11	1.11	1.13	1.15	1.15	1.17	1.17	1.17	1.19	1.20	1.21	1.22	1.25	1.26	1.27	1.29	1.30	1.33	1.34	1.34	1.35	1.36	1.40	1.46	1.47	1.49	1.55	1.66
19	1.12	1.13	1.14	1.16	1.16	1.19	1.19	1.20	1.22	1.23	1.24	1.25	1.28	1.29	1.31	1.32	1.34	1.38	1.38	1.38	1.40	1.40	1.44	1.51	1.52	1.54	1.61	1.75
20	1.14	1.14	1.16	1.18	1.18	1.21	1.22	1.23	1.24	1.25	1.27	1.27	1.31	1.32	1.34	1.36	1.37	1.41	1.42	1.43	1.43	1.44	1.49	1.57	1.59	1.60	1.68	1.82
21	1.15	1.16	1.18	1.20	1.20	1.23	1.24	1.25	1.26	1.30	1.30	1.30	1.34	1.35	1.38	1.40	1.41	1.46	1.46	1.47	1.48	1.49	1.54	1.63	1.64	1.66	1.75	1.90
22	1.16	1.17	1.19	1.22	1.22	1.25	1.26	1.27	1.29	1.30	1.32	1.33	1.37	1.38	1.41	1.44	1.46	1.50	1.51	1.51	1.52	1.54	1.60	1.69	1.63	1.70	1.82	1.99
23	1.18	1.19	1.21	1.24	1.24	1.26	1.28	1.29	1.32	1.33	1.35	1.36	1.40	1.42	1.45	1.48	1.49	1.55	1.56	1.56	1.57	1.58	1.65	1.75	1.77	1.80	1.90	2.11
24	1.20	1.20	1.23	1.26	1.26	1.30	1.31	1.33	1.34	1.36	1.38	1.39	1.44	1.46	1.49	1.52	1.54	1.60	1.60	1.61	1.62	1.64	1.70	1.82	1.84	1.87	1.98	2.18
25	1.21	1.22	1.25	1.28	1.28	1.33	1.34	1.35	1.38	1.39	1.42	1.43	1.48	1.50	1.53	1.57	1.59	1.65	1.66	1.67	1.68	1.69	1.76	1.89	1.91	1.94	2.06	2.27
26	1.23	1.24	1.27	1.31	1.31	1.35	1.36	1.38	1.40	1.42	1.45	1.46	1.51	1.54	1.58	1.61	1.63	1.70	1.71	1.72	1.73	1.75	1.82	1.96	1.99	2.02	2.15	2.38
27	1.25	1.26	1.29	1.33	1.33	1.38	1.39	1.41	1.43	1.45	1.49	1.50	1.56	1.58	1.62	1.66	1.68	1.75	1.77	1.78	1.79	1.81	1.89					
28	1.27	1.28	1.31	1.36	1.36	1.41	1.42	1.44	1.47	1.47	1.49	1.53	1.60	1.62	1.68	1.71	1.73	1.81	1.82	1.83	1.85	1.87	1.97					
29	1.29	1.30	1.33	1.38	1.38	1.44	1.45	1.45	1.49	1.50	1.52	1.56	1.61	1.64	1.71	1.76	1.79	1.81	1.88	1.90	1.91	1.93						
30	1.31	1.32	1.36	1.41	1.41	1.43	1.49	1.49	1.53	1.56	1.60	1.61	1.70	1.71	1.77	1.81	1.84	1.93	1.94	1.96	1.97	2.00						

TABLE VI

CROSS SECTIONAL AREA OF TUBING "At"

NOMINAL SIZE	OUTSIDE DIAMETER	INSIDED DIAMETER	WEIGHT #/ft EUE	At (Sq. In.)
3/4"	1.050"	.824"	1.20	0.333
1.0"	1.315"	1.049"	1.80	0.507
1 1/4"	1.660"	1.380"	2.40	0.669
1 1/2"	1.900"	1.610"	2.90	0.800
2.0"	2.375"	1.995"	4.70	1.307
2 1/2"	2.875"	2.441"	6.50	1.812
3.0"	3.500"	2.992"	9.30	2.590
4.0"	4.500":	3.958"	12.75	3.600

TABLE VII

FLUID LOAD CONSTANTS

PUMP PLUNGER SIZE	PLUNGER CONSTANTS	FLUID LOAD CONSTANTS
1 1/16" (27.0 mm)	0.132	0.384
1 1/4" (31.8 mm)	0.182	0.531
1 1/2" (38.1 mm)	0.262	0.765
1 3/4" (44.5 mm)	0.357	1.041
2.0" (50.8 mm)	0.466	1.360
2 1/4" (57.2 mm)	0.590	1.721
2 1/2" (63.5 mm)	0.729	2.125
2 3/4" (69.9 mm)	0.881	2.571
3 1/4" (82.6 mm)	1.231	3.590
3 3/4" (95.6 mm)	1.639	4.780
4 3/4" (120.7 mm)	2.630	7.670
5 3/4" (146.1 mm)	3.855	11.240

TABLE VIII
HYDROSTATIC HEAD AND FLUID WEIGHT

A.P.I. Gravity	Specific Gravity	kg. Per Cu. M	kPa Per Metre	Lbs. Per Gal	PSI Per Foot
50	0.780	780	7.644	6.50	0.338
46	0.797	798	7.802	6.65	0.345
44	0.806	808	7.893	6.73	0.349
43	0.811	811	7.938	6.76	0.351
42	0.816	816	7.983	6.80	0.353
41	0.820	821	8.029	6.84	0.355
40	0.825	826	8.096	6.88	0.358
39	0.830	830	8.142	6.92	0.360
38	0.835	835	8.187	6.96	0.362
37	0.840	840	8.232	7.00	0.364
36	0.845	846	8.277	7.05	0.366
35	0.850	851	8.323	7.09	0.368
34	0.855	856	8.368	7.13	0.370
33	0.860	862	8.436	7.18	0.373
32	0.865	866	8.481	7.22	0.375
31	0.871	871	8.526	7.26	0.377
30	0.876	877	8.594	7.31	0.380
28	0.887	888	8.684	7.40	0.384
26	0.898	899	8.797	7.49	0.389
24	0.910	911	8.911	7.59	0.394
22	0.922	923	9.024	7.69	0.399
20	0.934	935	9.159	7.79	0.405
18	0.946	948	9.272	7.90	0.410
15	0.966	967	9.476	8.06	0.419
12	0.986	988	9.657	8.23	0.427
10	1.000	1001	9.793	8.34	0.433
	1.030	1032	10.109	8.60	0.447
	1.050	1056	10.335	8.80	0.457
	1.075	1075	10.516	8.96	0.465
	1.080	1080	10.584	9.00	0.468
	1.130	1128	11.036	9.40	0.488
	1.150	1152	11.285	9.60	0.499
	1.170	1176	11.511	9.80	0.509
	1.200	1200	11.737	10.00	0.519
	1.250	1248	12.212	10.40	0.540
	1.270	1272	12.461	10.60	0.551
	1.290	1296	12.687	10.80	0.561
	1.320	1320	12.914	11.00	0.571
	1.370	1368	13.388	11.40	0.592
	1.390	1392	13.637	11.60	0.603
	1.410	1416	13.863	11.80	0.613
	1.440	1440	14.090	12.00	0.623
	1.490	1488	14.564	12.40	0.644
	1.530	1536	15.039	12.80	0.665
	1.560	1560	15.266	13.00	0.675
	1.610	1608	15.740	13.40	0.696
	1.650	1656	16.215	13.80	0.717
	1.680	1680	16.442	14.00	0.727
	1.740	1740	17.030	14.50	0.753
	1.800	1800	17.618	15.00	0.779
	1.860	1860	18.206	15.50	0.805
	1.920	1920	18.794	16.00	0.831
	1.980	1980	19.382	16.50	0.857
	2.000	2004	19.608	16.70	0.867
	2.060	2064	20.173	17.20	0.892

TABLE IX
CONVERSION TABLE
WEIGHTS GRAVITES SALINITIES

Notes	S.G.	Kpa / m	API	Kg / m	Water In PPM Total Solids	Psi / Ft
Very Heavy	1.140	11.152		1140	200 000 ppm	0.493
Oils	1.130	11.061		1129	187 000 ppm	0.489
	1.120	10.971		1120	175 000 ppm	0.485
	1.110	10.858		1110	160 000 ppm	0.480
	1.100	10.767		1100	145 000 ppm	0.476
	1.090	10.654		1090	130 000 ppm	0.471
	1.080	10.564		1080	115 000 ppm	0.467
	1.070	10.473	1	1070	100 000 ppm	0.463
	1.060	10.383	2	1060	85 000 ppm	0.459
	1.050	10.270	3	1050	70 000 ppm	0.454
	1.040	10.179	4.5	1040	55 000 ppm	0.450
	1.030	10.066	6	1030	40 000 ppm	0.445
	1.020	9.976	7	1020	30 000 ppm	0.441
	1.010	9.885	8.5	1010	15 000 ppm	0.437
Fresh Water	1.000	9.795	10	1000	zero ppm	0.433
	0.993	9.727	11	993		0.430
Heavy Oil	0.966	9.659	12	986		0.427
	0.972	9.523	14	972		0.421
	0.959	9.388	16	959		0.415
	0.947	9.274	18	947		0.410
	0.934	9.139	20	931		0.404
	0.922	9.026	22	922		0.399
	0.910	8.913	24	910		0.394
	0.898	8.799	26	898		0.389
	0.887	8.686	28	887		0.384
	0.876	8.573	30	876		0.379
	0.870	8.528	31	870		0.377
	0.865	8.483	32	865		0.375
	0.860	8.415	33	860		0.372
	0.855	8.370	34	855		0.370
Light Oils	0.850	8.324	35	850		0.368
	0.845	8.300	36	845		0.366
	0.840	8.234	37	840		0.364
	0.835	8.189	38	835		0.362
	0.830	8.121	39	830		0.359
	0.825	8.076	40	825		0.357
	0.820	8.030	41	820		0.355
	0.816	7.985	42	816		0.353
	0.810	7.940	43	810		0.351
	0.806	7.895	44	806		0.349
	0.797	7.804	46	797		0.345
	0.788	7.714	48	786		0.341
	0.780	7.646	50	780		0.338
Distillates	0.702	6.877	60	702		0.304
	0.669	6.560	70	669		0.290

TABLE X

FOR YOUR CONVENIENCE IN CONVERTING METERS PER NUMBER OF RODS

NO. OF RODS	METERS	NO. OF RODS	METERS	NO. OF RODS	METERS	NO. OF RODS	METERS
1	7.62	51	388.62	101	769.62	151	1150.62
2	15.24	52	396.24	102	777.24	152	1158.24
3	22.86	53	403.86	103	784.86	153	1165.86
4	30.48	54	411.48	104	792.48	154	1173.48
5	38.10	55	419.10	105	800.10	155	1181.10
6	45.72	56	426.72	106	807.72	156	1188.72
7	53.34	57	434.34	107	815.34	157	1196.34
8	60.96	58	441.96	108	822.96	158	1203.96
9	68.58	59	449.58	109	830.58	159	1211.58
10	76.20	60	457.20	110	838.20	160	1219.20
11	83.82	61	464.82	111	845.82	161	1226.82
12	91.44	62	472.44	112	853.44	162	1234.44
13	99.06	63	480.06	113	861.06	163	1242.06
14	106.68	64	487.68	114	868.68	164	1249.68
15	114.30	65	495.30	115	876.30	165	1257.30
16	121.92	66	502.92	116	883.92	166	1264.92
17	129.54	67	510.54	117	891.54	167	1272.54
18	137.16	68	518.16	118	899.16	168	1280.16
19	144.78	69	525.78	119	906.78	169	1287.78
20	152.40	70	533.40	120	914.40	170	1295.40
21	160.02	71	541.02	121	922.02	171	1303.02
22	167.64	72	548.64	122	929.64	172	1310.64
23	175.26	73	556.26	123	937.26	173	1318.26
24	182.88	74	563.88	124	944.88	174	1325.88
25	190.50	75	571.50	125	952.50	175	1333.50
26	198.12	76	579.12	126	960.12	176	1341.12
27	205.74	77	586.74	127	967.74	177	1348.74
28	213.36	78	594.36	128	975.36	178	1356.36
29	220.98	79	601.98	129	982.98	179	1363.98
30	228.60	80	609.60	130	990.60	180	1371.60
31	236.22	81	617.22	131	998.22	181	1379.22
32	243.84	82	624.84	132	1005.84	182	1386.84
33	251.46	83	632.46	133	1013.46	183	1394.46
34	259.08	84	640.08	134	1021.08	184	1402.08
35	266.70	85	647.70	135	1028.70	185	1409.70
36	274.32	86	655.32	136	1036.32	186	1417.32
37	281.94	87	662.94	137	1043.94	187	1424.94
38	289.56	88	670.56	138	1051.56	188	1432.56
39	297.18	89	678.18	139	1059.18	189	1440.18
40	304.80	90	685.80	140	1066.80	190	1447.80
41	312.42	91	693.42	141	1074.42	191	1455.42
42	320.04	92	701.04	142	1082.04	192	1463.04
43	327.66	93	708.66	143	1089.66	193	1470.66
44	335.28	94	716.28	144	1097.28	194	1478.28
45	342.90	95	723.90	145	1104.90	195	1485.90
46	350.52	96	731.52	146	1112.52	196	1493.52
47	358.14	97	739.14	147	1120.14	197	1501.14
48	365.76	98	746.76	148	1127.76	198	1508.76
49	373.38	99	754.38	149	1135.38	199	1516.38
50	381.00	100	762.00	150	1143.00	200	1524.00

NO. OF RODS	METERS	NO. OF RODS	METERS	NO. OF RODS	METERS	NO. OF RODS	METERS
201	1531.62	251	1912.62	301	2293.62	351	2674.62
202	1539.24	252	1920.24	302	2301.24	352	2682.24
203	1546.86	253	1927.86	303	2308.86	353	2689.86
204	1554.48	254	1935.48	304	2316.48	354	2697.48
205	1562.10	255	1943.10	305	2324.10	355	2705.10
206	1569.72	256	1950.72	306	2331.72	356	2712.72
207	1577.34	257	1958.34	307	2339.34	357	2720.34
208	1584.96	258	1965.96	308	2346.96	358	2727.96
209	1592.58	259	1973.58	309	2354.58	359	2735.58
210	1600.20	260	1981.20	310	2362.20	360	2743.20
211	1607.82	261	1988.82	311	2369.82	361	2750.82
212	1615.44	262	1996.44	312	2377.44	362	2758.44
213	1623.06	263	2004.06	313	2385.06	363	2766.06
214	1630.68	264	2011.68	314	2392.68	364	2773.68
215	1638.30	265	2019.30	315	2400.30	365	2781.30
216	1645.92	266	2026.92	316	2407.92	366	2788.92
217	1653.54	267	2034.54	317	2415.54	367	2796.54
218	1661.16	268	2042.16	318	2423.16	368	2804.16
219	1668.78	269	2049.78	319	2430.78	369	2811.78
220	1676.40	270	2057.40	320	2438.40	370	2819.40
221	1684.02	271	2065.02	321	2446.02	371	2827.02
222	1691.64	272	2072.64	322	2453.64	372	2834.64
223	1699.26	273	2080.26	323	2461.26	373	2842.26
224	1706.88	274	2087.88	324	2468.88	374	2849.88
225	1714.50	275	2095.50	325	2476.50	375	2857.50
226	1722.12	276	2103.12	326	2484.12	376	2865.12
227	1729.74	277	2110.74	327	2491.74	377	2872.74
228	1737.36	278	2118.36	328	2499.36	378	2880.36
229	1744.98	279	2125.98	329	2506.98	379	2887.98
230	1752.60	280	2133.60	330	2514.60	380	2895.60
231	1760.22	281	2141.22	331	2522.22	381	2903.22
232	1767.84	282	2148.84	332	2529.84	382	2910.84
233	1775.46	283	2156.46	333	2537.46	383	2918.46
234	1783.08	284	2164.08	334	2545.08	384	2926.08
235	1790.70	285	2171.70	335	2552.70	385	2933.70
236	1798.32	286	2179.32	336	2560.32	386	2941.32
237	1805.94	287	2186.94	337	2567.94	387	2948.94
238	1813.56	288	2194.56	338	2575.56	388	2956.56
239	1821.18	289	2202.18	339	2583.18	389	2964.18
240	1828.80	290	2209.80	340	2590.80	390	2971.80
241	1836.42	291	2217.42	341	2598.42	391	2979.42
242	1844.04	292	2225.04	342	2606.04	392	2987.04
243	1851.66	293	2232.66	343	2613.66	393	2994.66
244	1859.28	294	2240.28	344	2621.28	394	3002.28
245	1866.90	295	2247.90	345	2628.90	395	3009.90
246	1874.52	296	2255.52	346	2636.52	396	3017.52
247	1882.14	297	2263.14	347	2644.14	397	3025.14
248	1889.76	298	2270.76	348	2651.76	398	3032.76
249	1897.38	299	2278.38	349	2659.38	399	3040.38
250	1905.00	300	2286.00	350	2667.00	400	3048.00

TABLE XI
PUMP STROKE CHART

METAL PLUNGERS

BARREL LENGTH FEET	PLUNGER LENGTH FEET	PUMP STROKE INCHES
10	3	68
10	4	56
12	3	92
12	4	80
14	3	116
14	4	104
14	5	92
15	3	128
15	4	116
15	5	104
16	4	128
16	5	116
17	4	140
17	5	128
18	3	164
18	4	152
18	5	140
18	6	128
19	4	164
19	5	152
19	6	140
20	4	176
20	5	164
20	6	152
21	4	188
21	5	176
21	6	164
22	4	200
22	5	188
22	6	176
23	4	212
23	5	200
23	6	188
24	4	224
24	5	212
24	6	200
25	5	224
25	6	212
26	5	236
26	6	224
27	5	248
27	6	236
28	5	260
28	6	248
29	5	272
29	6	260
30	5	284
30	6	272

P.A. PLUNGER

BARREL LENGTH FEET	PLUNGER LENGTH FEET	PUMP STROKE INCHES
10	20	89
12	20	113
14	20	137
16	20	161
18	20	185
12	40	101
13	40	113
14	40	126
15	40	137
16	40	149
17	40	161
18	40	173
19	40	185
20	40	196
21	40	209
22	40	221
23	40	233
24	40	245
25	40	257
26	40	269
27	40	281
28	40	293
29	40	305
30	40	317

NOTES: ACCESSPRY ITEMS MAY ALTER STROKE IN PUMP
ie: SIDE KICKE R, HART GAS LOCK BREAKER. ECT.
BASED PM STANDARD SINGLE CAGES
FOR DOUBLE CAGES DEDUCT 3”
P.A. PLUNGER REFERS TO PRESSURE ACTIVATED OR JOHNSON-FAGG TYPE

FORMULA TO FIND REGUIRED BARREL LENGTH

MAX. UNIT STROKE + PLUNGER LENGTH + 18” F/FITTINGS + 24” TO SET PUMP

PUMP STROKE CHART

METAL PLUNGERS

BARREL LENGTH METERS	PLUNGER LENGTH METERS	PUMP STROKE CENTI METERS
3.05	0.91	173
3.05	1.22	142
3.66	0.91	234
3.66	1.22	203
4.27	0.91	295
4.27	1.22	264
4.27	1.52	234
4.57	0.91	325
4.57	1.22	295
4.57	1.52	264
4.88	1.22	325
4.88	1.52	295
5.18	1.22	357
5.18	1.52	325
5.49	0.91	417
5.49	1.22	386
5.49	1.52	357
5.49	1.83	325
5.79	1.22	417
5.79	1.52	386
5.79	1.83	357
6.10	1.22	447
6.10	1.52	417
6.10	1.83	386

BARREL LENGTH METERS	PLUNGER LENGTH METERS	PUMP STROKE CENTI METERS
6.4	1.22	417
6.4	1.52	447
6.4	1.83	417
6.71	1.22	508
6.71	1.52	478
6.71	1.83	447
7.01	1.22	438
7.01	1.52	508
7.01	1.83	478
7.32	1.22	569
7.32	1.52	538
7.32	1.83	508
7.62	1.52	569
7.62	1.83	538
7.92	1.52	599
7.92	1.83	569
8.23	1.52	630
8.23	1.83	599
8.53	1.52	660
8.53	1.83	630
8.84	1.52	691
8.84	1.83	660
9.14	1.52	721
9.14	1.83	691

P.A. PLUNGER

BARREL LENGTH METERS	PLUNGER LENGTH METERS	PUMP STROKE CENTI METERS
3.05	20	226
3.05	20	287
3.66	20	348
3.66	20	409
4.27	20	470
4.27	40	257
4.27	40	287
4.57	40	320
4.57	40	348
4.57	40	378
4.88	40	409
4.88	40	439
5.18	40	470
5.18	40	498
5.49	40	531
5.49	40	561
5.49	40	592
5.49	40	622
5.79	40	653
5.79	40	683
5.79	40	714
6.10	40	744
6.10	40	775
6.10	40	805

TABLE XII
CONVERSION FACTORS

Multiply this	x Factor	= Answer
Acre	43,560	Sq. Feet
	.004047	Sq. Kilometers
	4046.87	Sq. Meters
Atmospheres at 0^0C	14.7	Pounds/Sq. In.
Barrel	.159	Cu. Meter
	5.6146	Cu. Feet
	.159	Metric tons water at 60 ^{0}F
Barrel/Day	.159	Cu. Meter/Day
Centrigrade, (Degrees x 1.8)	+32	Deg. Fahrenheit (See table page 3)
Centimeter	.39370	Inches
Cu. Foot	.02831	Cu. Meter
Cu. Meter	6.2897	Barrels, 42 gallon
	35.3144	
Cu. Meter/Day	6.2897	Barrels/Day
E^3/m^3	35.31	Mcf/Day
Feet/Second	.3048	Cu. Feet/Barrel/Day
Foot	.30480	Centimeters
	.30480	Meters
Gallon, Liquid U.S.	.83267	Gallon, Liquid British
Gallon, British Imperial	1.2010	Gallon, Liquid U.S.
Gallon U.S./Minute	34.286	Barrels/Day
Gram	.002205	Pound, Avoirdupois
Inch	2.540	Centimeters
	.08333	Feet
KPa/M	÷ 22.62	PSI/Ft.
Kilogram	2.2046	Pound, Avoirdupois
Kilometer	.62137	Miles
Liter	.03531	Cu. Feet
	.26418	Gallon, Liquid U.S.
	.001	Cu. Meter
Meter	3.28083	Feet
	39.37	Inches
Mile, Statue	5280	Feet
	.86839	Mile Nautical

Millimeter	.03937	Inches
Pounds, Avoirdupois	453.5924	Grams
	16.0	Ounces
	.448	Dan
Pounds/Gallon, Liquid U.S.	7.48052	Pounds/Cu. Ft
PSI/Ft.	22.62	KPa/M
Pounds/Sq. Inch	.06805	Atmospheres
Sq. Centimeter	.1550	Sq. Inches
Sq. Inch	6.4516	Sq. Centimeters
Sq. Kilometer	.38610	Sq. Miles
Sq. Miles	2.590	Sq. Kilometers
Ton, Metric	1000	Kilograms
	2204.6	Pound, Avoirdupois
	1.1023	Ton, short
Ton Short	907.18	Kilograms
	2000	Pound, Avoirdupois
	.89286	Tons, long
Water Barrel 60^0F	350.2	Pounds
Water, Cu. Ft 39.1^0F	62.425	Pounds, Max Density
60^0F	62.366	Pounds
100^0F	62.0	Pounds

TEMPERATURE TABLES

Cent.	Fahr.
43.3	110
37.8	100
32.2	90
26.7	80
21.1	70
15.6	60
10.0	50
4.4	40
-1.1	30
-6.7	20
-12.2	10
-17.8	0
23.3	-10

Cent.	Fahr.
45	113.0
40	104.0
35	95.0
30	86.0
25	77.0
20	68.0
15	59.0
10	50.0
5	41.0
0	32.0
-5	23.0
-10	14.0
-15	5.0
-20	-4.0

Viscosity Chart

What is Viscosity?

The measure of the resistance of a fluid to flow.

What is Centipoise (cps)?

Water is the standard by which all Fluids are measured. Water is 1 cps 70 Degrees F.

What does Thixotropic mean?

Describes a fluid that is gel-like (ie. Toothpaste) at rest but will move with agitation.

EVERYDAY CONSUMABLE GOODS RELATED TO CENTIPOSE (CPS)

Water @ 70 degrees F	1	centipoise (cps)
Blood	10	centipoise (cps)
Ethylene Glycol	15	centipoise (cps)
Motor Oil (SAE 10)	50	centipoise (cps)
Corn Oil	65	centipoise (cps)
Maple Syrup	150	centipoise (cps)
Motor Oil (SAE 40)	250	centipoise (cps)
Motor Oil (SAE 60)	1,000	centipoise (cps)
Honey	2,000	centipoise (cps)
Molasses	5,000	centipoise (cps)
Chocolate Syrup	10,000	centipoise (cps)
Ketchup	50,000	centipoise (cps)
Peanut Butter	150,000	centipoise (cps)
Lard	100,000	centipoise (cps)

SUCKER ROD SPECIFICATIONS
GRADE "D"

Mfg.	UPCO	UPCO	UPCO	AOT	AOT	Weatherford	Weatherford	Weatherford	Weatherford	Weatherford
Grade	CD	AD	KD	75	78	Axelson S-67	Axelson S-87	EVI "KD"	Trico D-61	Trico D-63
	Carbon Steel	Chrome-Moly	Special Alloy							
Metal Type	1541M	4142M	4720	A-4330A	A-4142M	1029MD	3130MD	Special	4142	4720SR
Heat treatment	Full length	Full length	Full length	Normalized &	Normalized	Quenched &	Quenched &	Normalized &	Normalized &	Normalized &
	Normalized	Normalized	Normalized	tempered	tempered	tempered	tempered	tempered	tempered	tempered
	and tempered	and tempered	and tempered							
Chemical Properties										
(C) Carbon	0.40 - 0.44	0.40 - 0.45	0.19 - 0.23	0.30 - 0.35	0.40 - 0.45	0.22 - 0.29	0.22 - 0.29	0.18 - 0.25	0.40 - 0.45	0.19 - 0.23
(Mn) Manganese	1.35 - 1.55	0.75 - 1.00	0.85 - 1.05	0.60 - 1.20	0.65 - 1.10	1.00 - 1.32	0.71 - 1.00	0.60 - 1.05	0.75 - 1.00	0.85 - 1.05
(P) Phosphorous	0.035 max.	0.035 max.	0.35 max.	0.035 max.	0.035 max.	0.025 max.	0.025 max.	0.04 max.	0.035 max.	0.035 max.
(S) Sulfur	0.040 max.	0.40 max.	0.040 max.	0.40 max.	0.040 max.	0.040 max.	0.035 max.	0.40 max.	0.040 max.	0.40 max.
(Cr) Chromium	0.25 max.	0.80 - 1.10	0.80 - 1.05	0.80 - 1.00	0.80 - 1.10	0.20 max.	0.41 - 0.65	0.60 - 1.05	0.80 - 1.10	0.80 - 1.05
(Si) Silcon	0.20 - 0.30	0.15 - 0.30	0.15 - 0.35	0.15 - 0.35	0.15 - 0.35	0.15 - 0.30	0.15 - 0.35	0.15 - 0.35	0.15 - 0.30	0.15 - 0.35
(Fe) Iron										
(B) Boron										
(Co) Cobalt										
(Ni) Nickel	0.25 max.	0.25 max	0.90 - 1.20	1.65 - 2.00	0.45 max.	0.15 max.	0.70 - 1.00	0.90 - 1.50	0.25 max.	0.90 - 1.20
(Cu) Copper	0.35 max	0.45 max.	0.40 - 0.60	0.35 max.	0.35 max.	0.35 max.	0.35 max.		0.45 max.	0.40 - 0.60
(Mo) Molybenum	0.05 max.	0.15 - 0.25	0.22 - 0.30	0.20 - 0.30	0.15 - 0.25	0.05 max.	0	0.20 - 0.30	0.15 - 0.25	0.22 - 0.30
(V) Vanadium	0.05 max.	0.02 - 0.30	0.20 - 0.30	0.035 - 0.055	0.30 - 0.50				0.02 - 0.03	0.02 - 0.03
(Nb) Niobium										
Physical Properties										
Tensile, ksi	115 - 140	115 - 140	115 - 140	120 - 140	120 - 140	120 min.	125 min.	115 - 140	115 - 140	115 - 140
Yield, ksi	85 min.	85 min.	85 min.	90 min.	90 min.	110 - 125	115 - 130	90 min.	85 - 110	85 - 110
Elongation,8, in.%	10 min.%	10 min.	10 min.	10 min	10 min.	11 - 17	12 - 17	14 min.	10 - 15	14 min.
Reduction %	40 min.%	40 min.	40 min	45 min.	45 min.	55 - 65	55 - 65	50 min.	45 - 65	50 - 60
Hardness-Bn	229 - 293	229 - 293	229 - 293%	240 - 290	240 - 290	248 - 277	248 - 280	227 min.	240 - 290	227 - 260
Hardness-Rc	21 - 31	21 - 31	21 - 31	23 - 30	23 - 30	24 - 29	24 - 30	21 min.	23 - 31	21 - 24

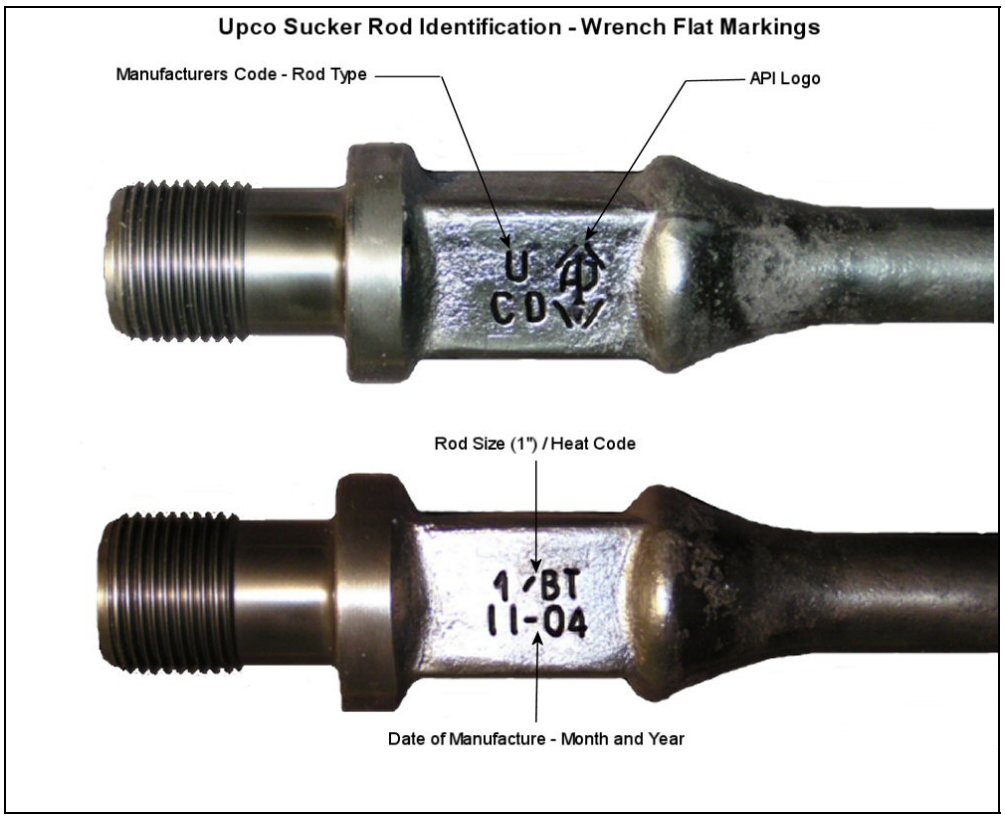
Specifications shown are based on manufacturers published information

SUCKER ROD SPECIFICATIONS
HIGH STRENGTH

Mfg.	**UPCO**	**Norris/AOT**	**Norris/AOT**	**Weatherford**	**Weatherford**	**Weatherford**	**Weatherford**	**Tenaris**	**Tenaris**	**Tenaris**
Grade	**H.S.**	**96**	**97**	**Axelson S-88**	**EVI EL**	**EVI XD**	**Trico T-66**	**Plus**	**UHS-NR**	**Special**
Metal Type	4138 Special	A4138M	A-4330A	3130Md	4138Md	4138 Md	4138M	1530M	4330M	4138M
Heat treatment	Full length	Normalized	Normalized	Quenched	Induction	Normalized	Normalized	Normalized	Normalized	Normalized
	Normalized and tempered	and tempered	and tempered	and tempered	Case hardened	and tempered	and tempered	and Superf.temp	and tempered	and tempered
Chemical Properties										
(C) Carbon	0.38 - 0.42	0.38 - 0.43	0.30 - 0.35	0.22 – 0.29	0.38 - 0.42	0.38 - 0.42	0.38 - 0.42	0.31 - 0.36	0.30 - 0.35	0.38 – 0.43
(Mn) Manganese	1.20 - 1.40	0.90 - 1.50	0.60 - 1.20	0.71 - 1.00	0.75 - 1.00	0.75 - 1.00	1.20 – 1.40	0.60 - 1.05	0.70 – 0.95	1.10 – 1.40
(P) Phosphorous	0.035 max.	0.035 max.	0.35 max.	0.025 max.	0.025 max.	0.035 max.	0.025 max.	0.04 max.	0.025 max.	0.025 max.
(S) Sulfur	0.040 max.	0.040 max.	0.040 max.	0.035 max.	0.035 max.	0.040 max.	0.025max.	0.40 max.	0.025 max.	0.0.25 max.
(Cr) Chromium	0.55 – 0.85	0.55 – 0.85	0.80 - 1.00	0.41 – 0.65	0.65 – 0.85	0.70 – 0.85	0.20 max	0.60 - 1.05		0.60 – 0.90
(Si) Silcon	0.20 - 0.35	0.20 – 0.35	0.15 - 0.35	0.15 - 0.35	0.20 - 0.35	0.20 – 0.35	0.25 - 0.40		0.15 – 0.35	0.20 – 0.40
(Fe) Iron										
(B) Boron										
(Co) Cobalt										
(Ni) Nickel	0.30 max.	0.30 max	1.65 – 2.00	0.70 – 1.00	0.30 max.	0.30 max.	0.30 max.	0.15 max.	1.65 – 2.00	0.30 max
(Cu) Copper	0.35 max	0.35 max.	0.35 max.	0.35 max.	0.35 max.	0.35 max.	0.35 max.	0.25 max.	0.25 max.	0.25 max.
(Mo) Molybenum	0.24 – 0.32	0.25 - 0.35	0.22 - 0.30	0.05 max	0.35 - 0.45	0.35 – 0.45	0.24 – 0.32	0.05 max.	0.20 – 0.30	0.025 – 0.35
(V) Vanadium	0.045 – 0.065	0.045 – 0.065	0.035 – 0.055		0.25 - 0.035	0.025 – 0.035	0.08 – 0.10	0.10 – 0.15	0.35 – 0.70	
(Nb) Niobium	0.030 – 0.040	0.027-0.043			0.035 – 0.045					
Physical Properties										
Tensile, ksi	140 - 160	135 - 150	140 - 150	145 min.		140 - 150	140 - 150	140 - 160	140 - 160	140 - 160
Yield, ksi	105 min.	115 min.	115 min.	130 - 145		115 min.	115 – 125 min.	115 min.	115 min.	115 min.
Elongation,8 in.,%	8 min.	10 min.	10 min.	11 - 17		14 min.	10 - 18			
Reduction %	30 min.	45 min.	45 min	50 - 65		45 min.	40 - 55			
Hardness-Bn	285 - 331	280 - 313	290 - 313	285 - 311		311 max.	290 - 311		331	
Hardness-Rc	30 - 36	29 - 32	30 - 32	30 - 32		32 max.	30 - 32		35	

Specifications shown are based on manufacturers published information

SUCKER ROD IDENTIFICATION



UPCO Type C – Light to medium loads, shallow to medium depths, non-corrosive or mild corrosive well fluids that are effectively inhibited against corrosion.
UPCO Type CD – Medium to heavy loads, medium to deep well depths, non-corrosive or mild corrosive well fluids that are effectively inhibited against corrosion
UPCO Type AD – Medium to heavy rod loads in medium to deep wells, mild to medium corrosive well fluids that are effectively inhibited against corrosion.
UPCO Type KD – Medium to heavy rod loads, at any depth in corrosive well fluids that are effectively inhibited against corrosion.
UPCO Type K – Light to medium loads, shallow to medium depths, where corrosion is a problem and the well fluids are effectively inhibited against corrosion.
UPCO Type HS – Extra rod loads, at any depth, non-corrosive or mild corrosive wells fluids that are effectively inhibited against corrosion.

LOADS		**DEPTHS**	
Light	Up to 25,000 psi (170 Mpa)	Shallow	Up to 4,000’ (1,200m)
Medium	Up to 35,000 psi (240 Mpa)	Medium	Up to 7,000’ (2,000m)
Heavy	Up to 42,000 psi (290 Mpa)	Deep	7,000’ plus (2,000m plus)
Extra Heavy	42,000 psi plus (290 Mpa)		

THE PRINCIPAL EFFECTS OF MAJOR ALLOYING ELEMENTS IN STEEL

ELEMENT	PERCENTAGE	PRIMARY FUNCTION
Manganese	0.25 - 0.40	Combines with Sulfur to prevent brittleness.
	>1.0%	Increases harden ability, by lowering transformation points & Causing transformation to be sluggish.
Sulfur	0.08 - 0.15	Free-Machining properties.
Nickel	2.0 - 5.0	Toughener.
	12.0 - 20.0	Corrosion resistance.
Chromium	0.5 - 2.0	Increases hardenability.
	4.0 - 18.0	Corrosion resistance.
Molybdenum	0.2 - 5.0	Stable carbides; inhibits grain growth.
Vanadium	0.15	Stable carbides; increases strength while retaining ductility; promotes fine grain size.
Silicon	0.2 – 0.7	Increases strength. Spring steels.
	2.0% Higher	Improve magnetic properties.

Above table printed from "Materials and Processes in Manufacturing" by E. Paul Degarmo 4th Edition.

In Summary, alloying elements added in small amounts of < 5% will increase strength and harden ability.
If added in larger amounts up to 20% then corrosion resistant properties are obtained.

NOTE: An alloy is any two metals combined together.

API STEEL ROD DESIGNS

ROD NO.	PLUNGER DIAMETER mm (in.)	ROD STRING (% OF EACH SIZE) 25.4 (1")	22.2 (7/8")	19.1 (3/4")	15.9 (5/8")	12.7 (1/2")
54	27 mm (1.0625")	---	---	---	0.446	0.554
54	31.75 mm (1.250")	---	---	---	0.495	0.505
54	38.1 mm (1.50")	---	---	---	0.564	0.436
54	44.45 mm (1.750")	---	---	---	0.646	0.354
54	50.8 mm (2")	---	---	---	0.737	0.263
54	57.15 mm (2.250")	---	---	---	0.834	0.166
55	ALL	---	---	---	1.000	---
64	27 mm (1.0625")	---	---	0.333	0.331	0.335
64	31.75 mm (1.250")	---	---	0.372	0.359	0.269
64	38.1 mm (1.50")	---	---	0.423	0.404	0.173
65	27 mm (1.0625")	---	---	0.344	0.656	---
65	31.75 mm (1.250")	---	---	0.373	0.627	---
65	38.1 mm (1.50")	---	---	0.418	0.582	---
65	44.45 mm (1.750")	---	---	0.469	0.531	---
65	50.8 mm (2")	---	---	0.520	0.480	---
65	57.15 mm (2.225")	---	---	0.584	0.416	---
65	63.5 mm (2.50")	---	---	0.652	0.348	---
65	69.85 mm (2.750")	---	---	0.725	0.275	---
66	ALL	---	---	1.000	---	---
75	27 mm (1.0625")	---	0.270	0.274	0.456	---
75	31.75 mm (1.250")	---	0.294	0.298	0.408	---
75	38.1 mm (1.50")	---	0.333	0.333	0.334	---
75	44.45 mm (1.750")	---	0.378	0.370	0.255	---
75	50.8 mm (2")	---	0.424	0.413	0.163	---
76	27 mm (1.0625")	---	0.285	0.715	---	---
76	31.75 mm (1.250")	---	0.306	0.694	---	---
76	38.1 mm (1.50")	---	0.338	0.662	---	---
76	44.45 mm (1.750")	---	0.375	0.625	---	---
76	50.8 mm (2")	---	0.417	0.583	---	---
76	57.15 mm (2.225")	---	0.465	0.535	---	---
76	63.5 mm (2.50")	---	0.508	0.492	---	---
76	69.85 mm (2.750")	---	0.565	0.435	---	---
76	82.55 mm (3.25")	---	0.687	0.313	---	---
77	ALL	---	1.000	---	---	---
86	27 mm (1.0625")	0.226	0.230	0.543	---	---
86	31.75 mm (1.250")	0.243	0.245	0.512	---	---
86	38.1 mm (1.50")	0.268	0.270	0.463	---	---
86	44.45 mm (1.750")	0.294	0.300	0.406	---	---
86	50.8 mm (2")	0.328	0.332	0.339	---	---
86	57.15 mm (2.225")	0.369	0.360	0.271	---	---
86	63.5 mm (2.50")	0.406	0.397	0.197	---	---
87	27 mm (1.0625")	0.243	0.757	---	---	---
87	31.75 mm (1.250")	0.257	0.743	---	---	---
87	38.1 mm (1.50")	0.277	0.723	---	---	---
87	44.45 mm (1.750")	0.303	0.697	---	---	---
87	50.8 mm (2")	0.332	0.668	---	---	---
87	57.15 mm (2.250")	0.364	0.636	---	---	---
87	63.5 mm (2.50")	0.399	0.601	---	---	---
87	69.85 mm (2.750")	0.439	0.561	---	---	---
87	82.55 mm (3.25")	0.516	0.484	---	---	---
87	95.25 mm (3.750")	0.612	0.388	---	---	---
88	ALL	1.000	---	---	---	---

ROD DATA

	DIAMETER		LENGTH		WEIGHT		CROSS SECTIONAL AREA	WEIGHT/ ROD	
FIBEROD			LENGTH/ROD						
ROD SIZE	BODY IN.	DIA. MM	FT	M	LBS/FT	KG./M	SQ. IN.	LBS.	KG.
3/4	0.740	18.796	37.5'	11.43	0.48	0.714	0.430	18.00	8.16
7/8	0.850	21.560	37.5'	11.43	0.61	0.885	0.567	22.88	10.38
1.0	0.980	24.770	37.5'	11.43	0.82	1.190	0.754	30.75	13.95
1.125	1.100	27.710	37.5'	11.43	1.09	1.710	0.950	40.88	18.54
1 1/4	1.225	31.120	37.5'	11.43	1.29	1.870	1.179	48.38	21.94
STEEL RODS									
5/8	0.625	15.875	25'	7.62	1.135	1.690	0.3068	28.38	12.87
3/4	0.750	19.050	25'	7.62	1.634	2.430	0.4418	40.85	18.53
7/8	0.875	22.225	25'	7.62	2.224	3.310	0.6013	55.60	25.22
1.0	1.000	25.400	25'	7.62	2.904	4.320	0.7854	72.60	32.93
1 1/8	1.125	28.575	25'	7.62	3.676	5.470	0.994	91.90	41.69
1 1/4	1.250	31.750	25'	7.62	4.5	6.700	1.227	112.50	51.03
1 3/8	1.375	34.925	25'	7.62	5.0	7.440	1.485	125.00	56.70
1 1/2	1.500	38.100	25'	7.62	6.0	8.930	1.767	150.00	68.04
1 5/8	1.628	41.275	25'	7.62	7.0	10.420	2.074	175.00	79.38
1 3/4	1.750	44.450	25'	7.62	8.2	12.200	2.405	205.00	92.99
2.0	2.000	50.800	25'	7.62	10.66	15.860	3.142	266.50	120.88

UPCO, INC.

TORQUE SPECIFICATIONS FOR SUCKER AND PONY RODS

UPCO "HS" – HIGH STRENGTH **

DIAMETER	3/4" 19.1 mm ft-lb	7/8" 22.2 mm ft-lb	1" 25.4 mm ft-lb	1-1/8" 28.6 mm ft-lb
T @ 100%	418	664	991	1411
T @ 80%	335	531	793	1129
T @ 50%	209	332	496	706
T @ 33%	139	221	330	470

UPCO API GR D – "CD" "AD" "KD"

DIAMETER	3/4" 19.1 mm ft-lb	7/8" 22.2 mm ft-lb	1" 25.4 mm ft-lb	1-1/8" 28.6 mm ft-lb
T @ 100%	339	538	802	1143
T @ 80%	271	430	642	914
T @ 50%	169	269	401	571
T @ 33%	113	179	267	381

**UPCO does not recommend the use of high strength sucker and pony rods for PCP (rotary) applications. High Strength rods are more brittle due to the hardness and tend to fail prematurely in PCP applications. The minimum yield strength on a high strength rod is also higher than an API Grade "D" rod, so obviously the torque specification per ft-lb is higher. However, the hardness of a high strength rod is also higher than an API Grade "D" which means it is also more rigid/brittle, if you will. Sucker rods were designed to operate in tension with very minimal side loading, etc. High strength rods were developed with greater tinsile strength than API grade rods. Unfortunately, the trade-off to get this higher tensile strength is a more brittle rod. The mechanical specifications of high strength rods indicate a lower percentage of elongation and reduction of area and increased hardness. To an engineer, this means that a high strength rod is not as tough as an API Grade "C" or "D" rod. The high strength rod cannot absorb as much stress before is breaks. It is less ductile; therefore, it is less able to withstand axial impacts. In a rotary application, we believe that a tough rod, rather than a higher tensile strength rod should be used. API Grade "C" rods are tougher than API Grade "D" and the "D" rods are tougher than the high strength.

MAXIMUM PULL LOAD CAPACITY
API SUCKER RODS

(For Use on Stuck Pumps)
(All Load Values in Pounds)

Rod Size		TYPE C Minimum Yield 65,000 PSI		TYPE D Minimum Yield 100,000 PSI		TYPE HIGH STRENGTH Minimum Yield 110,000 PSI	
In.	mm.	Lbs.	daN	Lbs.	daN	Lbs.	daN
5/8"	15.875	17,000	7,560	24,600	10,900	-	-
3/4"	19.05	24,000	10,800	35,400	15,800	44,700	19,900
7/8"	22.225	33,200	14,760	48,000	21,350	62,700	27,900
1.0"	25.4	43,400	19,300	62,800	27,900	82,000	36,500
1 1/8"	28.58	-	-	80,500	35,800	102,800	45,700

1b X .448 = dan

1 dan = 2248 #

Special Notes:

A) The above table gives the maximum pull load that may be applied to the smallest rod in a sucker rod string. This assumes a steady slow pull with no jerk or pull that runs into the load.

B) CAUTION: These load figures are based on the capacity of new steel. Sucker rods that have been in service for a long period of time may break under these loads.

C) For old rods or rods which have seen heavy loads during their life cycle, then the pull loads should be de-rated to 70% of above load values.

D) If two or more different grades are combined in the rod string, then pull to the lesser value.

SPECIAL CARE & HANDLING

RECOMMENDED FOR HIGH STRENGTH

SUCKER RODS

Because high strength sucker rods are heat treated to a greater hardness than API "D': grade rods in order to obtain the higher tensile strength they are more susceptible to H_2S embrittlement and flexing fatigue. Although the handling of high strength rods is no different than that what is laid out in API Recommended Practice for care and handling of Sucker rods bulletin #11 BR problems expected by not following these guidelines are more likely.

Special high strength rods commonly found in Canada include UPCO "HS", Weatherford "Axelson S-88"and Norris "97"and all share similar metallurgy.

Sections of API bulletin "11 BR" are attached and should be followed for handling all sucker rods.

Special care should be taken when handling HIGH STRENGTH rods in following areas:

LOADING & UNLOADING

- Use of a proper spreader bar when handling full bundles.
- Loose rods should be handled individually and never thrown or flipped.
- Extreme care should be taken to insure no nicks or bends occur.

HAULING

- Stack bundles so cross members are lined up.
- Always place dividers between loose rods in at least 4 places.
- Rods should never exceed length of trailer deck.
- Rods should be secured with straps located at cross members.
- **Absolutely No chains!**

SPECIAL CARE & HANDLING

PAGE 2

RUNNING

- Do not walk on rods without use of wooden walkway.
- When removing end caps ensure rods are not hammered or dinged.
- Ensure rods are tailed to rig floor to avoid bumping against floor.
- Elevators should be set onto the rod not jabbed to avoid putting nicks into the rod.
- It is recommended a hydraulic tong be used to ensure correct make-up, torque displacement cards are available based on manufacturers recommendations.
- Let blocks down gently, don't slam or jar elevators on top of rod table. Prevent jaws from nicking upset of rod, slow down 6' before landing on table.
- When breaking out the connections particularly with rod wrenches joints should never be hammered.
- If it is necessary to hammer joints the hammered pin or coupling should not be replaced in rod string.

APPLICATION

Hydrogen Sulfide Environments

First recommendation should always be to treat or inhibit sour fluid to ensure longer life of all equipment. It is not recommended rods having greater then Rockwell "C" hardness of 23 be run in H_2S environments.

Our recommendation is not to run high strength rods in wells having a H_2S content exceeding of 1-2%.

If high strength rods must be used in a corrosive environment utilize a .7 or less service factor according to the Goodman diagram.

Pumping Conditions

High speed pumping often causes rod buckling in the rod string (particularly the lower section) as well as shock loading which will cause premature rod failure.

Proper design and use of sinker bars can take the buckling effect out of the rod string.

Fluid pound caused by pumping off or incomplete pump fillage causes similar concerns.

Longer, slower strokes will increase life of high strength rods.

Excerpt from:
Recommended Practice for Care and Handling of Sucker Rods,
API Recommended Practice 11 BR (RP 11BR)

2.1 General

2.1.1. Rods should be inspected on delivery and thereafter as necessary to ensure that damaged rods are not placed in regular storage or in service.

2.1.3. Packaged rods should be preferably be handled and stored as a package unit, until the rods are to be run in the well. When removing the rods from the package, care should be exercised to use proper tools so that the rods may not be damaged, especially by nicking.

2.1.4. Rods are delivered by the mills, are provided with thread protectors on both the pin and coupling ends. Whenever these ends are observed to be without such protection, they should be inspected and if undamaged, the protectors should be replaced. Protectors should not be removed, except for inspection purposes, until the rods are hung in the derrick or mast preparatory to running.

2.1.5. Thread protectors, rod boxes, couplings, upsets, and wrench squares should never by hammered for any reason. One blow can so damage any part of a rod or coupling as to result in early failure.

2.1.6. Wooden walkways should be provided if it is necessary for crew members to walk on the rod stack or rod pile during unloading or loading operations.

2.2 Unloading and Loading

2.2.1. Care should be taken to avoid damaging the rods when removing bulkheads and tie-downs used to secure the rods during shipment.

2.2.2. Rods in packages should always be lifted and laid down with a handling device so designed as to support the package without damage to the rods.

2.2.3. Unpackaged rods should be handled individually. They should never be thrown nor flipped from or onto a railway car truck or stack. During all handling operations, the rods should be supported at least at two points to prevent excessive sagging or damaging contacts of any nature. Skids when used should be made of material not abrasive to the rod.

2.2.4. Trucks and trailers for handling packaged rods should provide blockage directly under the crosswise supports of the package so that the rods themselves will not be in contact with blockage. Further, the packages should be stacked so that the bottom supports rest squarely on the top supports of the next lower package. Tie-down chains, straps, or cables should be placed in such position as to pass over the crosswise supports.

2.2.5. Trucks and trailers for handling unpackaged rods should provide cross supports near the rod ends and at least two other equally spaced intermediate positions. When flat beds are used, the supports should be of such thickness as to prevent the rod ends or coupling from resting directly on the bed. Cross supports, spacers, and blocks should be of material non-abrasive to the rod. The rod layers should be separated by spacers positioned directly above the bottom supports. The spacers should be thick enough to extend a few inches beyond the stack on both sides. If the spacers are not notched, the outside rods in each layer should be chocked with blocks to prevent the rods from rolling of the spacer. Tie-down chains, cables, or straps should be placed in such positions as to pass over the ends of spacers. They should be prevented from contacting the rods in the top layer.

2.3 Storage of Rods

2.3.1. Rods should be stored separately according to grade and size. They should be stored in such locations and in such manner as to minimize deterioration from exposure to acid or other corrosive atmospheres. They should be stacked off the ground on racks or sills made of or surfaced with a material not abrasive to the rods.
2.3.2. For packaged rods, a rack or still should be provided under each support of the package. The packages should be stacked so that the supports are in vertical alignment. See Specification 11B: Sucker Rods, Par. 10.4 for packaging requirements.

2.3.3 For unpackaged rods, at least four rack or still supports should be located approximately one foot from the rod ends. The rod layers should be separated one foot from the rod ends. The rod layers should be separated by spacers placed directly above the rack or sill. The spacers should be thick enough to prevent the rods from contacting those in adjacent layers. If the spacers are not notched, the outside rods in each layer should be chocked with blocks to prevent the rods from rolling off the spacers.

2.3.4. Stored rods should be inspected at regular intervals. Any rust should be removed with a wire brush and a suitable protective coating applied.

2.3.5. When rods are returned to storage after use, the threads should be cleaned, lubricated, and covered with clean, undamaged thread protectors. The rods surfaces should be covered with a protective coating

Excerpt from:
Recommended Practice for Care and Handling of Sucker Rods, API Recommended Practice 11 BR (RP 11BR)

2.4 Field Distribution and Handling

2.4.1. When rods are taken from storage and loaded on trucks for field distribution, the same precautions should be observed in loading, transporting, and unloading as recommended herein for placing new rods in storage.

2.42. When rods are unloaded at the well, they should not be placed on the ground. They should be located in such position that they will not be run over by a truck nor where heavy equipment may be set or dropped on them. Particular care should be taken to ensure that they are not walked on.

2.5 Running and Pulling

2.5.1. Single rods should be tailed into the mast. Special care should be taken to ensure that they do not touch the ground, other rods, or any part of the mast. Also during tailing do not allow the rods to be raised with elevator latches.

2.5.2. For maximum efficiency and to minimize the risk of damage to the rods, it is recommended that suitable hangers be provided in the mast.

2.5.3. Rod elevators, hooks, wrenches and other tools should be suitable for the job and in good condition. They should be inspected regularly for wear and other damage, and should be repaired or replaced when their continued use might result in damage to the rods. Special attention should be given to elevators and hooks to ensure that they are maintained and cleaned to avoid dropping the rod string.

2.5.4. In order to avoid cross threading, care should be taken that servicing equipment is so positioned that the rods, when hanging free in the rod elevators, are centered directly over the well. When stabbing the rod pin into the coupling, the rod should hang straight (without slack) so as to avoid cross threading. Should cross threading occur, the joints should be broken, a die run over the pin and a tap into the coupling; after which the threads should be cleaned, inspected and relubricated.

2.5.5. After removal of the thread protectors, the rod pin thread and face, and the coupling thread and face, should be thoroughly cleaned by brushing and flushing if necessary, and then inspected for damage. Couplings or rods with damaged or excessively worn threads or faces should be reconditioned or discarded. Any nick, deformation, or foreign material on the shoulder or coupling faces may cause premature failure. The pins should always be relubricated after cleaning and inspection.

2.5.6. For best uniform makeup results, the use of either air or hydraulic power rod wrenches is recommended.

2.5.7. To obtain satisfactory results in makeup of sucker joints, the joint must be clean, undamaged, well lubricated and have a free-running fit to shoulder contact if applied circumferential displacement is to sufficiently preload the joint to prevent shoulder face separation during pumping.

2.5.8. On breaking out connections, particularly with hand wrenches, the joint should never be hammered, and the proper coupling and rod wrenches, with the assist of cheater bars, should be used if a joint is unbreakable by ordinary procedure.

2.5.9. Any hammered or over-torqued couplings should be discarded since hammering and over-torquing damages the coupling, faces, threads, and may strip the pin threads.

2.5.10. During makeup, the joint should be observed to determine that the coupling face makes proper contact with the shoulder face. When proper contact is not made, the joint should be broken, cleaned, inspected, and relubricated.

2.5.11. Whenever rods are pulled, they should be carefully inspected for damage before being rerun. Kinked, bent, or nicked rods are permanently damaged and should be discarded.

2.5.12. In breaking the joints, care should be exercised that the threads and contact faces are not damaged.

2.5.13. If a rod hanger is not provided, the rods should be pulled and laid down in singles. The same care should be exercised in handling and stacking the pulled rods as herein recommended for new rods.

Excerpt from:
Recommended Practice for Care and Handling of Sucker Rods,
API Recommended Practice 11 BR (RP 11BR)

SECTION 5
SUCKER ROD JOINT MAKEUP UTILIZING CIRCUMFERENTIAL DISPLACEMENT

5.1. General

5.1.1. For optimum performance it is imperative that all of the joints in the string in the rods be made up to a given preload stress level in order to prevent separation between the pin should and the coupling face during the pumping cycle.

5.1.2. There are many inherent variables which affect joint makeup. Among these are the differences in materials, the smoothness of surface finishes and the lubricity of lubricants, as well as the operating characteristics and mechanical condition of the power tong equipment. As a result, applied torque has not proven to be the most accurate, nor the most practical means of measuring the preload stress level in a sucker rod joint.

5.1.3. Both test data and theoretical calculations show that circumferential displacement beyond hand-tight makeup of coupling and pin provides an accurate and repeatable means with which to measure and define the preload stress in a sucker rod joint.

5.1.4. In view of the foregoing, this recommended practice provides, for field use, a comprehensive set of circumferential displacement values and procedures covering their use, including a method for the calibration of power tongs.

5.2. Circumferential Displacement Values. Circumferential displacement as used herein is the distance measured, after makeup, between the displaced parts of a vertical line scribed across the external surfaces of the box and pin when they are in a shouldered hand-tight relationship prior to makeup. See Fig. 5.1 and 5.2.

5.2.1. The circumferential displacement values shown in Table 5.1 are the necessary and recommended displacements required to achieve an optimum preload stress. Values for a combination of materials and their application are listed in the column headings. Choose the correct column.

5.2.2. Because the interface surfaces of the joint are burnished or smoothed out on initial makeup, the displacement values on initial makeup are greater than those on subsequent makeup. While this difference in displacement occurs in varying degrees with all rod grades, it is observed to be consistent only in the Grade D. Rod. Notice, the tabulated values for use when rerunning Grade D Rods are smaller than those for the initial makeup of new Grade D Rods.

5.2.3. It is impractical to establish displacement values for the initial makeup of Grade C and K Rods because of the inconsistency of observed test data with these materials. It is therefore recommended that new Grade C and K Rods joints be made up and broken, in the field prior to final makeup on initial installation.

5.2.4. When new couplings are installed on previously used rods regardless of their grade, the displacement values in Table 5.1.Column 3, should be used.

TABLE 5.1
SUCKER ROD JOINT CIRCUMFERENTIAL DISPLACEMENT VALUES
All dimensions in inches followed by equivalent in mm.

1	2		3	
	Running New Grade D Displacement Values		Rerunning Grades C, D, & K Displacement Values	
Rod Size	Minimum	Maximum	Minimum	Maximum
½ (12.7)	6/32 (4.8)	8/32 (6.3)	4/32 (3.2)	6/32 (4.8)
5/8 (15.9)	8/32 (6.3)	9/32 (7.1)	6/32 (4.8)	8/32 (6.3)
¾ (19.1)	9/32 (7.1)	11/32 (8.7	7/32 (5.6)	17/64 (6.7)
7/8 (22.2)	11/32 (8.7)	12/32 (9.5)	9/32 (7.1)	23/64 (9.1)
1 (25.4)	14/32 (11.1)	16/32 (12.7)	12/32 (9.5)	14/32 (11.1)
1 1/8 (28.6)	18/32 (14.3)	21/32 (16.7)	16/32 (12.7)	19/32 (15.1)

NOTE: Above displacement values were established through calculations and strain gage tests.

5.3. General Recommendations, Power Tongs

5.3.1. The use of air or hydraulic power rod wrenches is recommended to assure best makeup results for all size of rods. However, it is imperative that the power wrenches be maintained in accordance with the manufacture's recommendations.

5.3.2. When using power wrenches, it recommended that the hydraulic power oil system be circulated until a normal operating temperature is reached and that this temperature be maintained within a reasonable level through calibration and installation of rods.

5.4. Calibration of Power Tong

5.4.1. Power tong must be calibrated to produce recommended circumferential displacement make-up values shown by Table 5.1. After initial calibration, it is recommended that the power tong calibration be checked each 1,000 feet (300m) and be calibrated for each change in rod sizes.

5.4.2. There are three different methods employed in calibrating power tongs for various API Grade rods and field conditions. It is imperative to select the recommended method to suit your field conditions.

5.4.2.1. Calibration of Power Tongs for New API Grade D Rods

- **a.** Check condition outlined under Par. 5.1.1.
- **b.** Set the tongs operating pressure on the low side of the estimated value required to produce prescribed circumferential displacement value shown by Table 5.1.
- **c.** Screw the first joint together hand tight, scribe a fine vertical line across the pin and coupling shoulder to establish hand-tight reference as shown by Fig. 5.1.1.

Excerpt from:
American Petroleum Institute

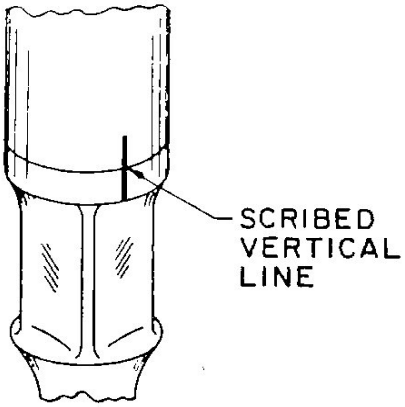


Fig. 5.1
HAND-TIGHT JOINT

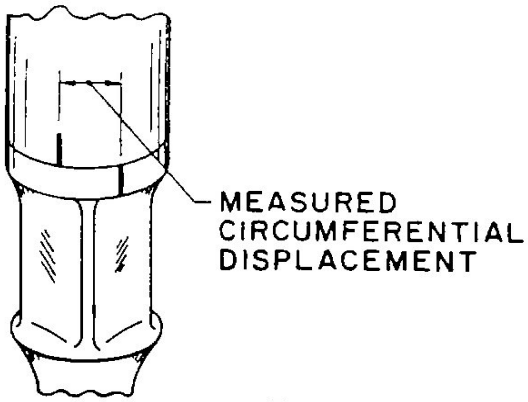


Fig. 5.2
MADEUP JOINT

d. Loosen coupling to normal running position then up joint with power tong operating with the tong throttle depressed to the fully open position. Do not hit the throttle a second time after joint shoulder and tongs have stalled.

e. Remove the tongs and measure the circumference entail displacement between the scribed hand-tight vertical line as shown by Table 5.2.

f. Increase or decrease the tong operating pressure to achieve the selected prescribed circumferential displacement as shown by Table 5.1.

g. Repeat steps D. through F. until proper displacement is achieved. Check calibration of tongs a minimum of 4 joints and for each 1000 feet thereafter and at each change in rod sizes.

5.4.2.2. Calibration of Power Tongs for AP Grade C and Grade K Rods

a. For the initial run of API Grade C and Grade K Rods, a constant correction factor cannot be recommended because of inherent variables involved. Therefore, it is imperative to make up and break the connection prior to calibration of power tongs if proper preload is to be assured.

b. Once the joint is made up and broken, follow the same procedure as outline in Par. 5.4.2.1. steps A through G. using the appropriate circumferential displacement values in Table 5.1.

5.4.2.3. Calibration of Power Tongs for re-running of all Grades of API Rods and New Couplings.

Employ values shown in Table 5.1. Column 3 and follow same procedures as outlined in Par. 5.4.2.1. steps A. through G.

5.5. Use of Rod Wrenches for Manual Makeup

5.5.1. The use of rod wrenches is not recommended for rod sizes larger than ¾ inch. Application of rod wrenches to achieve the desired preload is as follows.

5.5.1.1. Manual Make-up of New API Grade D Rod Strings

a. Screw rod coupling to a shoulder hand-tight position.

b. Scribe a fine vertical line across the pin and coupling to establish a hand-tight reference as shown by Fig. 5.1.

c. Apply necessary mechanical force to achieve recommended displacement values as shown in Table 5.1. Column 3.

5.5.1.2. Mechanical Make-up of API Grade C and Grade K Rods.

d. Apply mechanical force and make up joint once. Loosen and retighten to hand-tight position.

e. Scribe a fine vertical line across the pin and coupling shoulder to establish a hand-tight reference as shown BY Fig. 5.1.

f. Apply necessary mechanical force to achieve recommended displacement values as shown in Table 5.1, Column 3.

5.5.1.3. Mechanical Make-up of Used Rods and New Couplings.

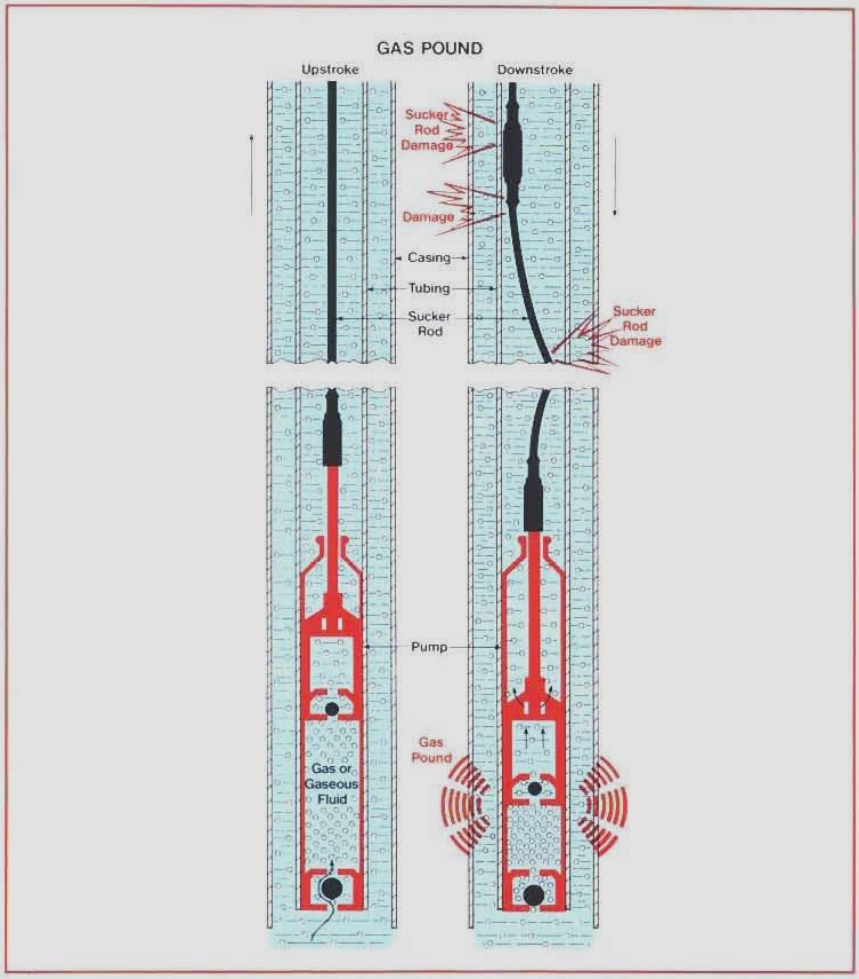
g. Bring coupling and rod pin to a hand-tight position.

h. Scribe a fine vertical line across the pin and coupling shoulder to establish a hand-tight reference as shown by Fig. 5.1.

i. Apply mechanical force sufficient to achieve circumferential displacement as shown in Table 5.1., Column 3.

NOTE: The hand tight position as used in Section 5 is attained when full shouldered adjustment is made.

GAS POUND



Many wells produce gas along with the well fluids. The presence of free or break-out gas at the pump can interfere with the efficiency of the pump action, thereby reducing the amount of fluid produced. This interference can result in a gas pound and when extreme it results in completely gas locking the pump.

During the pumping unit upstroke, the pump barrel is filled with fluid and free gas, usually in a frothy condition. On the downstroke, the rod and fluid loads above the plunger must compress this gas until the pressure above and below the traveling valve are equalized to allow the traveling valve to open and discharge the gas and fluid into the tubing. At this time, a pound or shock wave similar to that produced by a fluid pound, only cushioned more, travels through the system.

Gas pounds cause the same problems with equipment and production as fluid pounds. Fluid pounds are controllable to a high degree, whereas gas pounds can usually only be partially controlled. Some control can be maintained if gas separation is possible before the gas enters the pump, but where gas breaks out of solution during the pressure drop within the pump, only partial control can be maintained. In a situation where gas completely fills the pump barrel the pump gas locks, which means that not enough pressure or vacuum can be built within the pump to open either the traveling or standing valve and production will cease.

A gas pound can cause the same severe damages as a fluid pound.

A gas pound may be identified as follows:

1. Fluid at the bleeder valve is frothy and foamy and has a tendency to blow out instead of flowing.
2. Production varies greatly from day to day.
3. Theoretical bottom hole pump efficiency below 70% with 20% and 10% not uncommon.
4. Fluid level readings in the annulus vary due to froth.
5. A gas pound, as reflected on a dynamometer card trace, constantly changes as the gas volume in the pump changes.



Handling gas interference in pumping wells is at best a trial and error problem. There is no best method for every well. Some suggestions to control gas pounds are:

Remedy

1. Reduce casing back pressure to only a few ounces but do not open to atmosphere.
2. Lower tubing perforations and pump intake as far below casing perforations or formation face as possible to prevent turbulence at the intake which starts vertical gas flow.
3. Install a downhole gas separation system to keep as much gas as possible out of the pump. A simple mud anchor—gas anchor system often works. Where the gas breaks out will determine the system to be tried.
4. Design the bottom hole pump to increase the compression ratio, such as close valve spacing, oversized standing valve and intake, etc. Work toward reducing turbulence inside the pump.
5. Try a backpressure valve on the flowline to help hold gas in solution.
6. Vary unit strokes per minute and stroke length.
7. Do not bump bottom to break gas locking. This will damage the pump as well as creating a secondary shock wave through the pumping system.
8. Change bottom hole pump design to better handle such gaseous fluids.

FLUID POUND

A great many pumping wells pound fluid, either intentionally or unintentionally, and any well is subject to pounding depending on many pumping conditions.

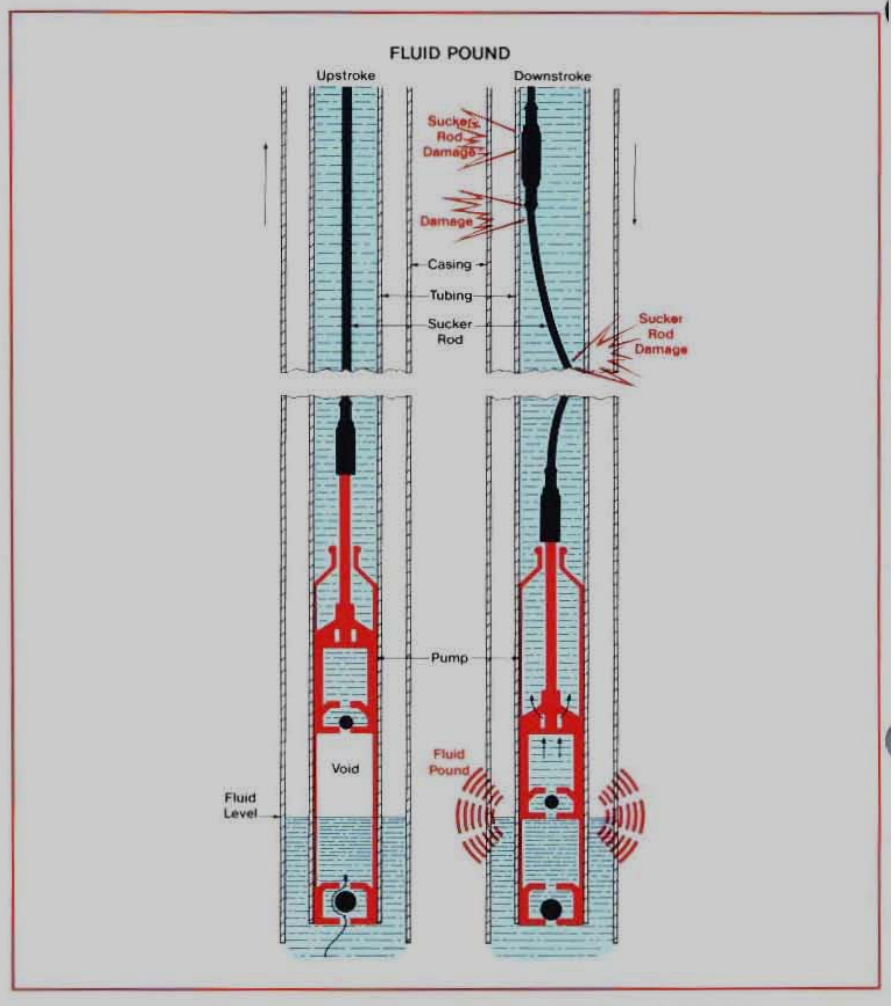
A "fluid pound," as experienced in oil well pumping, is caused by the pump not completely filling with fluid on the upstroke. As the downstroke begins, the entire fluid and sucker rod load moves down through a void until the plunger hits the fluid level in the pump barrel. The traveling valve opens, suddenly transferring the load to the tubing, causing a sharp decrease in load which transmits a shock wave through the pumping system. It is this shock wave that damages the parts of the pumping system.

A fluid pound is always undesirable and we recommend that the pumping system be monitored to detect a pound and changes be made in the system to eliminate or reduce the pound. The worst condition is when the pound occurs near the middle of the downstroke as the velocity of the falling loads are maximum and the resulting shock wave is greater.

In some wells the only way a pumper knows he is getting all of the fluid available is to pound the well. Under this situation, the system should be changed to keep the pound at the top of the downstroke where the resulting effect of the shock wave is less.

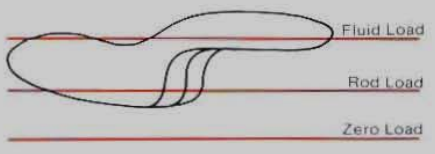
A fluid pound can cause severe damage as follows:

1. The sucker rod tends to bend in the same area on each downstroke due to the buckling effect. This stretches the skin on the convex side of the sucker rod bend. This repetitive bending eventually creates fatigue cracking at this point. Such fatigue cracking ultimately leads to failure.
2. The inhibitor film from the portion of the sucker rod that slaps against the tubing wall is removed by such rubbing action. It also causes wear of the rod at this point due to abrasion. Both conditions can result in failure.
3. Contributes to unscrewing of the rod and coupling caused by this bending motion and slapping the tubing.
4. Creates excessive stress on pump parts due to shock loading.
5. If tubing is not anchored, it also bends or buckles due to sudden load changes.
6. Pumping unit gear boxes and bearings can be damaged from the shock wave effect.
7. Increases lifting costs due to unnecessary pulling costs resulting from any of the above.
8. Production is lost due to such downtime.



A fluid pound may be identified as follows:

1. The pumping unit carrier bar turns on the downstroke.
2. The shock wave of the pound in shallow wells can often times be felt by holding the hand on the polished rod.
3. Production per day is less than the particular pumping cycle is capable of producing.
4. A fluid level test indicates the fluid level to be below the top of the pump barrel.
5. A dynamometer card trace will be nearly consistent, with the slope of the pound very steep when the pound occurs in the middle of the stroke.



Well costs can be reduced by keeping fluid pounds to a minimum consistent with maintaining maximum available production. The following are suggestions to make the pumping system more equal the amount of fluid available to it from the well, thus controlling the fluid pound.

Remedy

1. Change operational design by changing the stroke length, pumping speed, or pump size or design. The objective would be to change toward a longer stroke at a slower speed and/or reduce the plunger diameter.
2. Time cycle the pumping time to allow the pump barrel to fill.
3. Reduce casing back pressure, but do not open casing to atmosphere.
4. Lower pump as far as possible to increase submergence.
5. Install pump-off controller on pumping unit.
6. Keep casing and tubing perforations and pump intake open, clean, and treat against scale buildup.

III RECOMMENDED STROKE LENGTHS AND STROKES PER MINUTE AT GIVEN DEPTHS

To help ensure success in pumping deeper wells, the following table is provided as a guide for minimum stroke lengths for different depths. The problem of downhole friction reducing production has occurred when using shorter stroke lengths than those recommended in the table.

The maximum speed indicated can be exceeded, but only after the actual well loads are verified by a dynamometer card survey.

DEPTH		STROKE LENGTH		MAXIMUM S.P.M.
FT	M	IN.	CM.	
4,500- 6,000	1,300-1,800	74	188	17
6,000- 7,500	1,800-2,200	86	218	15
7,500- 9,000	2,200-2,700	100	254	13.5
9,000-10,500	2,700-3,200	120	305	12.5
10,,500-12,000	3,200-3,600	144	366	10.5
12,000-13,500	3,600-4,100	168	427	9
13,500-15,000	4,100-4,600	192	488	8
15,000-16,500	4,600-5,000	216	549	7
16,500-18,000	5,000-5,500	240	610	6

SIZING THE PUMP

The pump length should be calculated with the highest pump intake pressure.

FORMULA FOR CALCULATING THE WORKING PUMP LENGTH:

$\frac{\text{9" x Footage of glass rods x 1.75}}{1000}$	_____ inches
+ Maximum predicted downhole pump stroke or surface stroke (whichever is greater)	+_____ inches
+ Plunger length (in inches)	+_____ inches
$+ \frac{\text{2" x Seating Nipple Depth}}{1000}$	+_____ inches
= Total length of pump	=_____ inches
/12 = length of pump in feet	=_____ feet
X .3048 = length of pump in Meters	=_____ meters

EXAMPLE:

$\frac{\text{9" x 5090 feet of glass x 1.75}}{1000}$	80 inches
+ 146" downhole pump stroke	+ 146 inches
+ 5' plunger length x 12 inches	+ 146 inches
$+ \frac{\text{2" x 7500 seating nipple depth}}{1000}$	+ 15 inches
= Total length of pump in inches	= 301 inches
/12 = Total length of pump in feet	= 25 feet
X .3048 = length of pump in meters	= 7.62 meters

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New Technologies Optimize Production

By Maggie Lee Special Correspondent

Developments in production technology are being shaped both by producers' desire to maximize the value of existing oil and gas fields and their need to bring hydrocarbons in from new wells and fields.

With strong commodity prices, operators are taking a hard look at even the most mature properties to determine how applying new technologies or services could help optimize production and add value to their producing assets. On the other hand, production technology is also evolving to support the new frontiers in exploration and production, including deeper, hotter and higher-pressured reservoirs, unconventional resources, and remote operations in demanding environments.

Right on cue, equipment manufacturers and service providers are responding to the operating trends of the day–from enhanced recovery operations in older fields, to coalbed methane development, to higher-pressure/higher-temperature deep onshore wells, to ultradeepwater projects in the Gulf of Mexico–with an assortment of new tools and techniques designed to help operators make the most of their production operations.

Fiberglass Sucker Rods

The slightly higher cost of fiberglass sucker rods have historically made them applicable only in select situations, such as deep, high-volume and corrosive downhole environments. But, according to Russ Rutledge, chief executive officer of Fibercom, the introduction of the company's new 3/4- and 7/8-inch fiberglass rods are changing all that.

"These new Fiberod® rods are priced competitively with steel," he says. "Now production companies can get all the benefits of fiberglass for about the same price as steel rods. The rods are stronger and lighter than steel, and are impervious to corrosion. The advantages of fiberglass rods include increased production, reduced pumping unit loads, decreased electrical consumption, electrolysis reduction, fewer tubing wear failures and less down time."

In addition to the 3/4- and 7/8-inch sizes, Fibercom also offers 1-inch and 1 1/4-inch fiberglass rods. "The 1- and 1 1/4-inch rods have been around long enough to demonstrate their value to producers," Rutledge holds. "The smaller sizes of fiberglass rods have the same advantages, but they have the added benefit of being cost-competitive with steel."

Applications of the larger sizes tend to be in deeper, higher-volume wells where downhole conditions tend toward the extreme, Rutledge continues. "Although the 1- and 1 1/4-inch fiberglass rods cost slightly more than steel on a unit cost basis, they provide benefits that cannot be achieved using steel," he remarks. "Those benefits include operational cost savings and efficiency improvements. In fact, the rods are guaranteed to not only outperform steel rods, but save money in the process."

The ¾- and 7/8-inch rods are engineered for shallow to midrange well depths. "With oil and gas production costs continuing to increase each year, fiberglass rods make more sense than ever," Rutledge maintains. "Rod failures resulting from stress corrosion will be eliminated, surface equipment will be unloaded, electrical consumption will be reduced and production ranges will be increased."



Fibercom's new 3/4- and 7/8-inch Fiberod® sucker rods give operators the advantages of stronger, lighter and corrosion-resistant fiberglass rods at a cost that is comparable to conventional steel rods.

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UPCO SINKER BARS

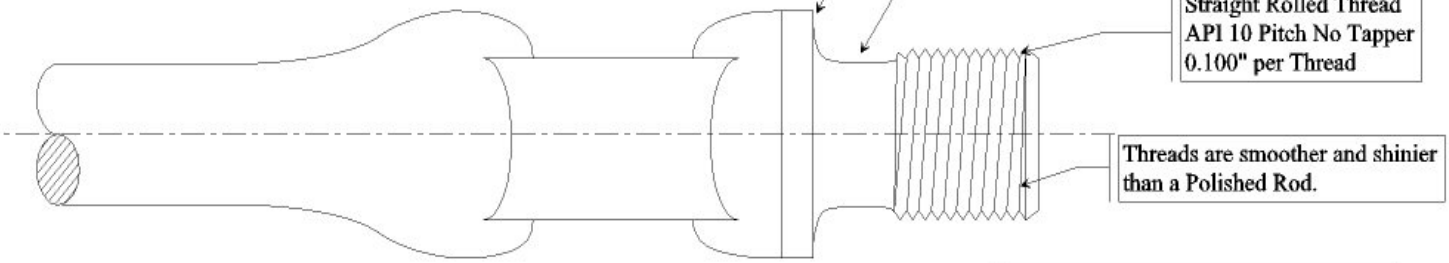
The following description and dimensions are for UPCO sinker bars which are manufactured to API specifications. These dimensions are standard for UPCO but can be altered if customer wants different pin size or wrench flat dimensions required.

SIZE	ELEVATOR NECK	PIN SIZE	WRENCH FLAT WIDTH	SUCKER ROD WRENCH SIZE
1-3/8" X 25' 34.9 mm X 7.62 M	1.0" 25.4 mm	3/4" 19.05 mm	1.0" 25.4 mm	3/4" & 7/8" 19.05 & 22.225 mm
1-1/2" X 25' 38.1 mm X 7.62 M	1.0" 25.4 mm	3/4" 19.05 mm	1-5/16" 33.3 mm	1.0" 25.4 mm
1-5/8" X 25' 41.3 mm X 7.62 M	1.0" 25.4 mm	7/8" 22.225 mm	1-5/16" 33.3 mm	1.0" 25.4 mm

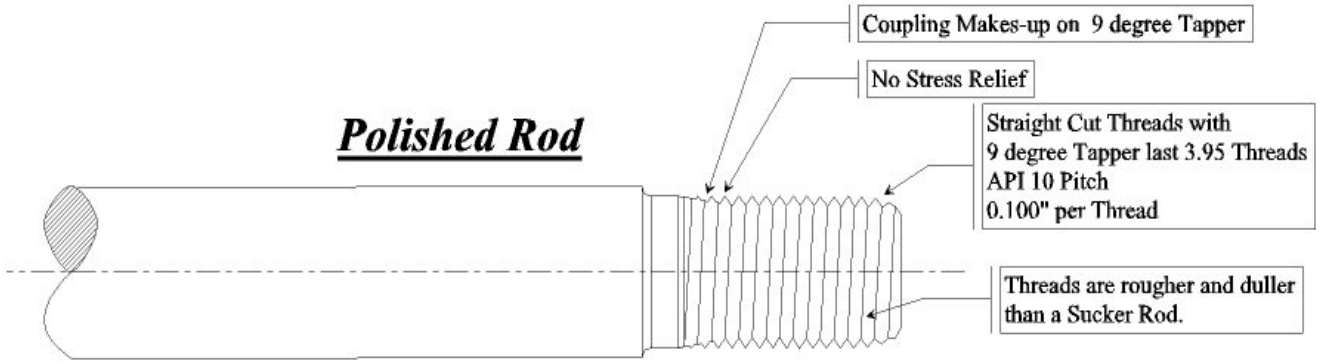
Pin sizes larger than the above standards are manufactured and supplied to customers upon request. Larger pin sizes may decrease the connection strength because not enough shoulder exists to get the full connection strength between the coupling and the shoulder pin.

Visual Differences Between Polished Rods and Sucker Rods

Sucker Rod



Polished Rod



UPCO	DRAWING #: DPVSR #1	CLAREMORE, OKLAHOMA SUCKER ROD PLANT
	REVISION: #0.0	Visual Difference Between Polished Rods and Sucker Rods
	APPROVED BY: WCR	REVISION DATE: 4/8/05 DRAWN BY:

POLISHED ROD COUPLINGS FOR POLISHED ROD PINS

The question arises from time to time on just what happens when a sucker rod coupling is made up on a polished rod pin.

For sucker rods with sufficient pin shoulder, the coupling will face-contact the pin shoulder. The polished rod pin, of course, has no shoulder but relies on the 9 degree taper of the pin at the shank end to face a matching polished rod coupling for make up.

But, when a sucker rod coupling is made up on a polished rod pin, the counter bore of the coupling rides up and over the polished rod pin shank. With sufficient torque, the coupling is expanded as it progresses to the largest diameter of the polished rod. The yield point is exceeded if the rod coupling expands, thus weakening the joint for possible failure.

A polished rod coupling can be used on a sucker rod pin with no negative effect except for stabbing difficulty when running in with service units. You will recall that one of the reasons for undercutting pins and counter boring sucker rod couplings was for a greater running ease. (Cross threading was fairly common with the old style pin.) The primary reason, of course, was to more accurately pre-load the pin with calculable make up torque.

Polished rod couplings should be run on polished rod pins. Polished rod couplings, sucker rod couplings, and sub-couplings conform to API specifications.

Notice that the box thread on polished rod couplings and sub-couplings have the 9 degree run-out, or "vanishing thread" as some call it, to mate with the polished rod pin 9 degree taper on the shank end. The sucker rod coupling has a counter bore and straight thread silhouette. This coupling depends on face contact with sucker rods or upset end of polished rods and sufficient torque applied to properly make-up.

POLISH RODS

Polished rods have pin type threaded connections that have different threads from sucker rods. The polished rod thread has a 9 degree angle in the back of the thread that the polished rod coupling makes up on. Therefore, a polished rod coupling must be used to connect the polished rod to the sucker rods. A polished rod coupling will shoulder up properly on a sucker rod, but a sucker rod coupling will not make up on a polished rod thread.

The polished rod carries the weight of the entire rod string plus the fluid load and imposed dynamic loads. This makes it a critical piece of equipment and care must be taken to ensure that it is properly installed and maintained. A polished rod will fail due to fast fatigue type stress if it is improperly installed. However, a properly selected and properly installed rod will have a long service life.

POLISH RODS ARE AVAILABLE IN DIFFERENT MATERIALS:

Piston Steel - Are manufactured from cold drawn 1045 carbon steel. They are recommended for light to moderate loads where corrosion is not a factor.

Alloy Steel - Polished rods are made from chromium – molybdenum alloy steel (4140). Designed for moderate to heavy loads in wells with mild corrosive fluids that have been effectively inhibited against corrosion.

Spray Metal - Polished rods are manufactured from cold drawn 1045 carbon steel with a hard spraymetal surface applied to the OD. They are recommended for abrasive and corrosive conditions under moderate to heavy loads.

Stainless Steel - Manufactured from type 431 stainless steel. Recommended for moderate loads under most corrosive conditions.

High Strength SS - Manufactured from Nitronic 50 stainless steel. Recommended for heavy loads in most corrosive conditions.

*** Refer to chart on facing page for chemical and mechanical properties.

POLISH ROD SPECIFICATIONS

	1045 Piston Steel	Spray Metal	4140 Alloy	431 SS	XM-19 SS	VDM
Chemical Properties		Uses Piston Steel Base				
Carbon	0.43 - 0.50	0.43 - 0.50	0.38 - 0.43	.20 Max	0.06	0.02
Manganese	0.60 - 0.90	0.60 - 0.90	0.75 - 1.00	1.0 Max	4.0 - 6.0	1
Phosphorous	0.04 Max	0.04 Max	0.035 Max	.04 Max	0.04 Max	1
Sulfur	0.05 Max	0.05 Max	0.04 Max	.03 Max	0.03 Max	0.005
(Cr.) Chromium	0.13	0.13	0.80 - 1.00	15.0 - 17.0	20.5 - 23.5	20
(Si) Silcon	0.25	0.25	0.15 - 0.35	1.0 Max	1.0 Max	0.5
Iron						
Boron						
Cobalt					0.89	
(Ni) Nickel	0.12	0.12	0.21	1.25 - 2.50	11.5 - 13.5	24.5
(P) Phosphorus	0.04 Max	0.04 Max				
(Cu) Copper	0.29	0.29	0.27		0.45	
(Mo) Molybenum	0.017	0.017	0.15 - 0.25		1.5 - 3.0	6.8
(C) Carbon	0.45	0.45				
(Mu.) Man						
(Mn) Manganese	0.8	0.8				
(S) Sulfer	0.05 Max	0.05 Max				
(V) Vanadium	0.03	0.03				
Physical Properties						
Tensile	130,000 - 145,000	130,000 - 145,000	120,000 - 150,000	120,000 - 150,000	140,000 - 165,000	120,000
Yield	85,000 - 90,000	85,000 - 90,000	90,000 - 110,000	90,000 - 110,000	110,000 - 145,000	90,000
Elongation	19%	9 - 12%	14 - 16 %	16 - 20 %	20 - 25%	
Hardness	20 - 26 Rc	55 - 66 Rc	28 - 34 Rc	28 - 30 Rc	25 - 32 Rc	35 Rc

Specifications shown are based on manufacturers published information

PROPER INSTALLATION OF POLISH RODS

In order to obtain the maximum life out of a polished rod, certain precautions must be taken:

i) Make sure that the polished rod is directly over the hole. This is referred to as being "level". Check the rod with a carpenter's level in several positions of the stroke to make sure it is level. (See diagram "A" & "C".)

ii) The carrier bar must be level under the polished rod clamp so that both sides of the bridle carry an equal load. Otherwise, a bending moment is placed on the rod directly under the clamp. (See diagram "B".)

iii) Place the polished rod clamp on bare steel only, never on the sprayed metal surface. The hard sprayed metal is very thin so it is easily cracked by the clamp since the steel under the sprayed metal is softer. This crack is an initiating point for a fatigue crack type failure. Fatigue is the type of failure mode of polished rods 99% of the time.

Other factors that will affect the polished rod life are: pounding fluid, gas pounding, fast pumping (more than 1400 inches/minute linear speed, multiply SPM X stroke length), and improper application of size or material.

Polished rod liners are made to provide a smooth, hard, sprayed metal surface for rods that are not coated. They are also available in brass material. They fit closely around the polished rod and are very thin and easily bent. Therefore, care must be taken when installing liners. A liner strokes through the stuffing box which must be equipped with oversize rubbers to seal against it. The liner is attached to the polished rod below the polished rod clamp, and has a packing element that needs to be tightened against the polished rod and seal against well fluids.

SPACING GUIDELINES FOR APPLYING MOULDED SCRAPERS

FOR PARAFFIN CONTROL

Two key factors determine proper spacing of scrapers for effective paraffin control:
1) The distance between scrapers must not exceed the effective stroke length.
2) Scrapered rods should extend from the surface to slightly below the point in the well where paraffin begins to form (cloud point).

To determine the required number of molded-on scrapers per 25-foot sucker rod, verify effective stroke length and consult the chart below.

PARAFFIN SCRAPER SPACING REFERENCE CHART

Effective Surface Stroke (inches/cm)	**Scrappers Required per Rod** Steel Rods (Per 25' Rod)	Fiberglass Rods (Per 37.5' Rod)
120"/305cm -- Plus	4	5
100"/254cm -- 120"/305cm	4	5
85"/216cm -- 100"/254cm	4	6
64"/163cm -- 85"/216cm	5	7
54"/137cm -- 64"/163cm	6	8
44"/112cm -- 54"/137cm	7	9
37.5"/95cm -- 44"/112cm	8	
31"/ 79cm -- 37.5"/95cm	9	

Figure 1

SPACING FORMULA

$$\frac{\text{ROD LENGTH (inches)}}{\text{Stroke (inches)}} + 1 = \text{NUMBER OF GUIDES/ROD}$$