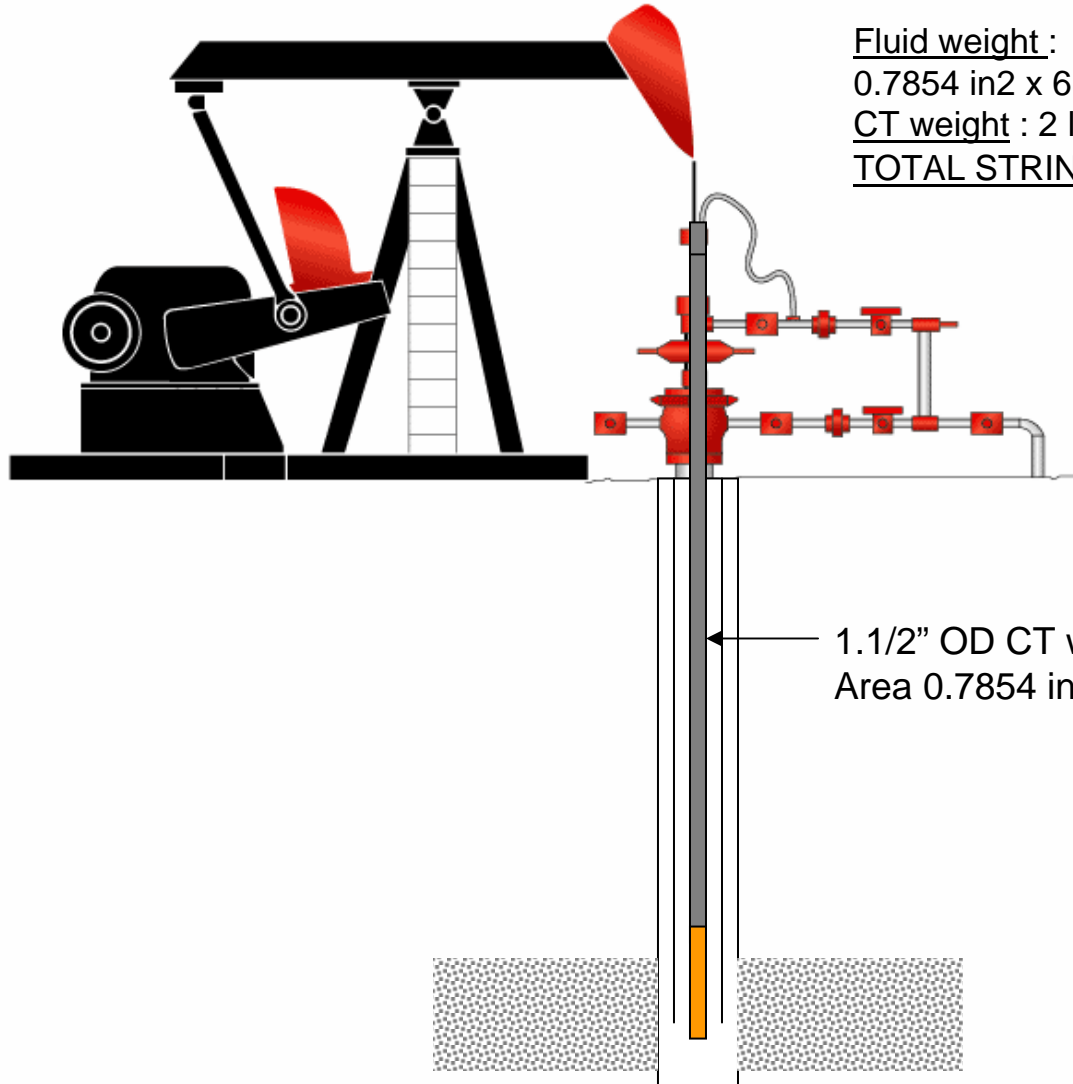


Pumping with coiled tubing

Comparison of string weight and stiffness between conventional pumping string with sucker rods and the innovative pumping system with Coiled Tubing.

Pumping with Coiled Tubing



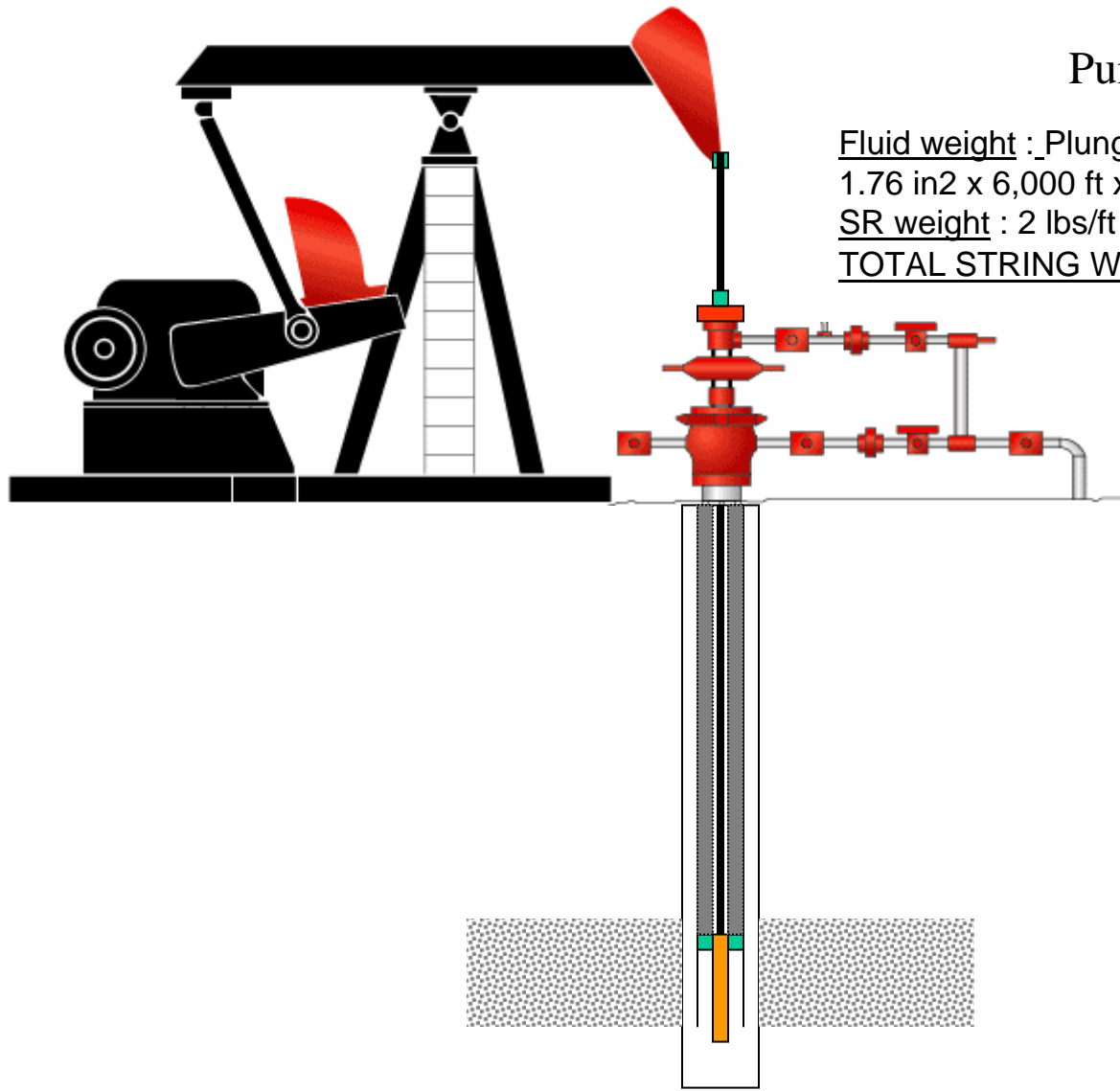
Fluid weight : CT ID area x CT Length x 0.433 psi/ft

$0.7854 \text{ in}^2 \times 6,000 \text{ ft} \times 0.433 \text{ psi/ft} = 2,040 \text{ lbs}$

CT weight : $2 \text{ lbs/ft} \times 6,000 \text{ ft} = 12,000 \text{ lbs}$

TOTAL STRING WEIGHT = $14,400 \text{ lbs}$

1.1/2" OD CT w/ 1" ID
Area 0.7854 in² ID



Pumping with Sucker Rods

Fluid weight : Plunger OD area x CT Length x 0.433 psi/ft

1.76 in² x 6,000 ft x 0.433 psi/ft = 4,591 lbs

SR weight : 2 lbs/ft x 6,000 ft = 12,000 lbs

TOTAL STRING WEIGHT = 16.591 lbs

Torque comparison

Formulas

Static load = weight of string + weight of fluid

Impulse factor "T" = length of stroke x spm² / 70.500

Dynamic rod load = 1 + T x weight of string

Peak polished rod load = (1+T) x weight of string + weight of fluid

Minimum load = weight of string x 0.76 - T

Load range = Peak polished rod load – minimum load

Peak torque = Load range x length of stroke / 4

Example with 1.1/4 Coiled Tubing

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Static load = 12,000 + 2,040 = 14,400 lbs(*)

Impulse factor = 54 x 36 / 70.500 = 0,027

Dynamic load = (1 + 0.027) 14,400 = 14,788 lbs

Peak polished rod load = 1 + 0,027 x 14,788 + 1 = 15,188 lbs(**)

Minimum rod load = 14,788 x 0.76 – 0,027 = 10.839 lbs

Load range = 15,188 – 10,839 = 4,349 lbs

Peak torque = 4,349 x 54 / 4 = 58,711 lbs.inch

(*) Steel + water inside

(**) minimum fluid level, fluid @ pump

Example with Sucker rods and 1.1/2" plunger

Static load= 12,000 + 4,591= 16,591 lbs

Impulse factor "T"= 54x36/70500=0,027

Dynamic load = 1 + 0,027x 12,000 = 12,324 lbs

Peak polished rod load= (1+0.027)x 12,000 + 4,591=17,038lbs

Minimum load =12,000 x 0.76-0.027= 8,796lbs

Load range= 17,038 – 8,796 = 8,242 lbs

Peak torque = 8,242 x 54/4= 111,267 lbs.inch

Steel weight and stiffness

<u>Diameter</u>	<u>Weight</u>	<u>Moment of Inertia</u>
• 1" CT.....	1 lb/ft	0.037
• 1.1/4 CT.....	1.5 lb/ft	0.070
• 1.1/2" CT.....	2 lb/ft	0.128
• 3/4" Rods.....	1.6 lb/ft.....	0.015
• 7/8" rods.....	2.24 lb/ft.....	0.032
• 1" Rods.....	2.9 lb/ft.....	0.049