DUAL DISPLACEMENT PRODUCTION SYSTEM

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The need to produce large volumes of fluids from secondary recovery wells, and to produce normal levels of fluid from deeper wells, made possible an innovative artificial lift option using a Dual Displacement Pump.(Fig. 1)
Reciprocated with a standard beam pumping unit using coiled tubing, this production system (patent pending) consist in reciprocating a plunger of a down hole pump, were both motions of the pumping unit are utilized to convey fluid to surface. While in the down stroke production reaches surface through the annular space between CT and production tubing, in the up stroke fluids reach the surface through the annular space between CT and production tubing,

The pump design incorporates two independent sets of traveling valves and two sets of standing valves with only one plunger/barrel configuration.

The full use of the pumping cycle makes possible to produce up to 80% more fluid per unit of time, making this production system the ideal option to replace ESP's or PCP's in secondary recovery wells.

While the primary goal of this design has been targeted to the secondary recovery wells, this production system will also solve problems associated with rod strings in deeper wells. The capability of this pump to produce, at least, one and a half times more fluid per cycle will allow the use of a smaller diameter plungers for a given production rate, thus reducing stresses in the pumping string due to fluid weight.

Small plunger diameters will allow, a) the optimization of the pumping string and pumping unit, and
b) to reach production from deeper wells.

One important remark to take in consideration, is that this pump is not suitable for gas handling because due to its design, one of the stages will be highly susceptible of gas locking.

Its also possible to use this pump with sucker rods instead of CT. However the ultimate goal is to use it with CT.

The first prototype is presently undergoing test, and the results are going to be shared in future papers.

This production system can lift more than 1,000 bls of fluidlday with a conventional pumping unit at slow SPM rates and standard stroke lengths.
See chart below:

Volumes in bls/day with 86" stroke ideal for 228 or 320 pumping unit							
Pump bore	6 SPM	7 SPM	8 SPM	9 SPM	10 SPM	11 SPM	12 SPM
1.3/4"	289	336	384	432	480	528	576
2"	385	449	512	576	640	704	768
2.1/4"	504	588	672	756	840	924	1008
Volumes in bls/day with 144" stroke ideal for a 456 or 640 pumping unit							
1.3/4"	510	595	680	765	850	935	1020
2"	700	816	933	1050	1166	1283	1400
2.114"	900	1050	1200	1350	1500	1650	1800
2.112"	1104	1288	1472	1656	1840	2024	2208
Volumes in blslday with 168" stroke ideal for 640 pumping unit							
1.314"	570	621	850	935	1020	1105	1207
2"	816	935	1054	1207	1309	1445	1564
2.114"	1020	1190	1360	1530	1700		
2.112"	1275	1479	1700	1955	2125		

POLISHED ROD LOAD ON A DUAL DISPLACEMENT PUMP

CTRS (Coiled Tubing Rod String) with regular rod pump @ 3,000 ft

Sucker rod string. Polished rod load by weight of steel:
3,000 ft of SR (30% 7⁄8" rods + 70% ¾" rods), 1,971lbs + 3,402lbs = 5,373 lbs

Sucker rod string plus coupling effect
5,373lbs x 1.10..... = 5,910 lbs

CT string. Polished rod load by steel weight
3,000 ft of CT (3,000 ft x 1.9lbs/ft) ..... = 5,700 lbs

CT string. Fluid Weight
3,000 ft of water (3,000 ft x 0.433psi/ft x 1.22 sq.inch)..... = 1,584 lbs

CT string, plus fluid load:
Total CT string load.....5,700lbs + 1,584lbs..... = 7,284 lbs

Fluid weight by plunger diameter in sucker rod pumping.:

Plunger	Load
1.112"	(1.77 sq inch x 3,000ft x 0,433psi/ft) = 2,299 lbs
1.314"	(2.41 sq inch x 3,000ft x 0,433psi/ft) = 3,130 lbs
2"	(3.14 sq inch x 3,000ft x 0,433psi/ft) = 4,078 lbs
2.1/4"	**(3.97 sq inch x 3,000ft x 0,433psi/ft) = 5,157 lbs**

Fluid weight by plunger diameter in CTRS pumping. i.e. 400 ft fluid level above pump.

Plunger	Load
1.112"	[(1.77sq inch – 0,7854sq inch)x400ftx0,433psi/ft] = 169 lbs
1.3/4"	[(2.41sq inch – 0,7854sq inch)x400ftx0,433psi/ft] = 280 lbs
2"	[(3.41sq inch – 0,7854sq inch)x400ftx0,433psi/ft] = 453 lbs
2.1/4"	**[(3.97sq inch - 0,7854sq inch)x400ftx0,433psi/ft] = 551 lbs**

PUMPING WITH CTRS VS ROD PUMPING, TOTAL POLISHED ROD LOAD (LBS):

Plunger	*pumping with **Sucker rods***	*pumping with **CT***	*% **difference***
1.1/2"	5,910 + 2,299 = 8,209	7,284 + 169 = 7,453	10%
1.314"	5,910 + 3,130 = 9,040	7,284 + 280 = 7,564	17%
2"	5,910 + 4,078 = 9,988	7,284 + 453 = 7,737	23%
2.1/4"	5,910 + 5,157 = 11,067	7,284 + 551 = 7,835	30%

PUMPING WITH DUAL DISPLACEMENT (DDPS) TOTAL POLISHED ROD LOAD:

When pumping with DDPS everything remains pretty much the same with exception of fluid level . When Dual Pumping with CT, in the up-stroke, CT acts as sucker rod string , therefore we have to consider 3,000 ft of fluid instead of 400 ft above pump. The annular space between CT and production tubing, and the CT are both full of fluid by priming the system prior to start the pumping cycle

FLUID WEIGHT GIVEN PLUNGER DIAMETER AND 1" HOLLOW PULL ROD:

Plunger Load

1.112" [(1.77sq inch – 0,7854sq inch)x3,000ftx0,433psi/ft] = 1,278 lbs
1.314" [(2.41sq inch – 0,7854sq inch)x3,000ftx0,433psi/ft] = 2,110 lbs
2" [(3.41sq inch – 0,7854sq inch)x3,000ftx0,433psi/ft] = 3,409 lbs
2.114" [(3.97sq inch – 0,7854sq inch)x3,000ftx0,433psi/ft] = 4,136 lbs

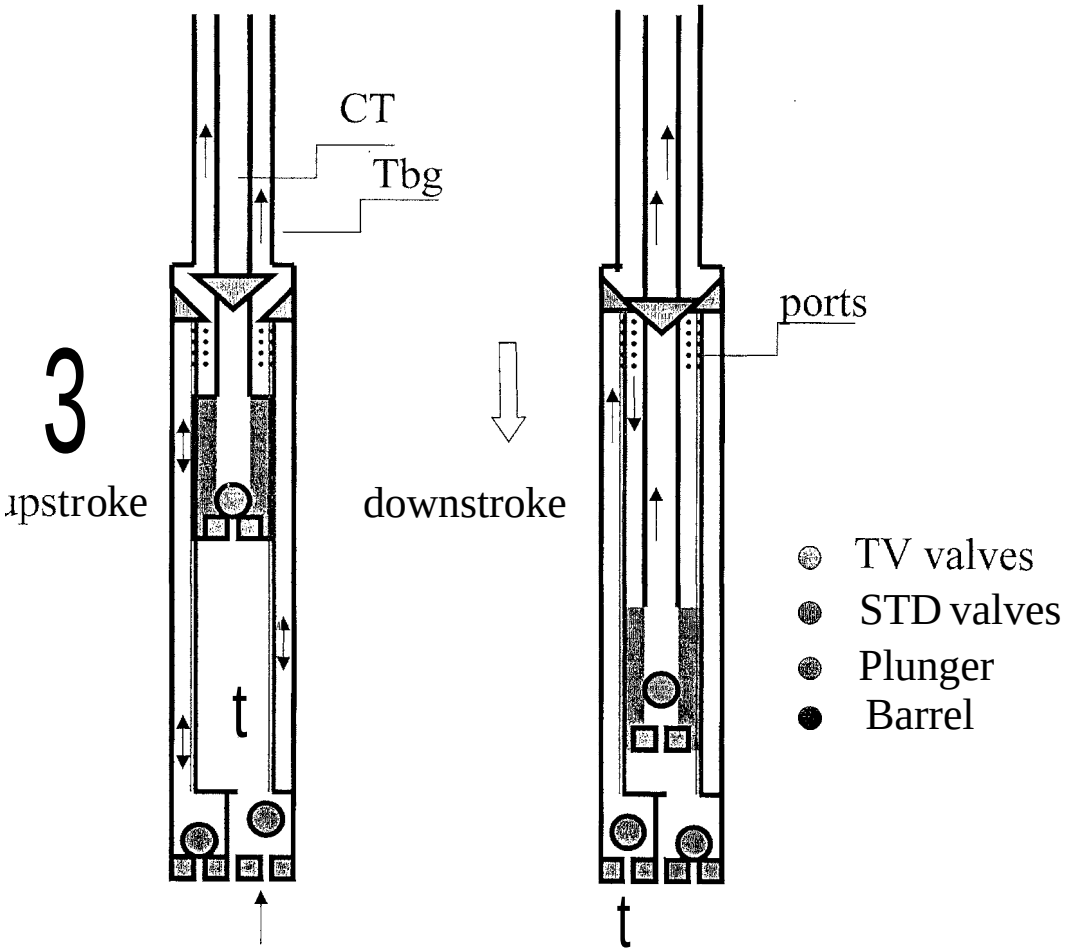
DUAL PUMPING WITH CT. TOTAL POLISHED ROD LOAD (LBS):

Plunger	*pumping with Sucker rods*	DDPS *pumping with CT*	*Difference*
1.1/2"	5,910 + 2,299 = 8,209	7,284 + 1,278 = 8,562	+ 353 lbs
1.3/4"	5,910 + 3,130 = 9,040	7,284 + 2,110 = 9,394	+ 354 lbs
2"	5,910 + 4,078 = 9,988	7,284 + 3,409 = 10,693	+ 705 lbs
2.1/4"	5,910 + 5,157 = 11,067	7,284 + 4,136 = 11,420	+ 353 lbs

CONCLUSIONS:

DDPS

- More production with the same pumping cycle
- Uses full pumping cycle
- Same pumping unit
- Similar polished rod load when compared with sucker rods string
- Eliminates all sucker rod couplings
- Eliminates Polished Rod
- No couplings, eliminates "rod wear"; stiffer string, greater moment of inertia.
- CT is run pre-primed. No waiting time to start production or spacing pump
- Cleaner and safer job
- Means to circulate fluids with CT in future workover's
- Minimizes pipe hauling in and out of location
- Reduces power consumption compared with ESP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CT
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STD valves
Plunger
Barrel

Figure 1