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Research Article

Study of the Increase in Production by the Performance of the Esp Electric Submersible Pump in an Lw 753 Well in Dr Congo

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Abstract

This study focuses on the optimization of the production of the Liawenda 753 well, a non-eruptive oil well located in the Turonian reservoir. Faced with the decrease in reservoir pressure and the inherent limitations of well drainage mechanisms, the use of an artificial lifting system is necessary. Initially equipped with a progressive cavity pump (PCP), the well is to be equipped with an electric submersible pump (ESP) in order to improve its performance.

The main objective of this study is to evaluate the impact of replacing the PCP with a PSE on the production flow rate of the Liawenda 753 well. To do this, we will analyze historical production data, reservoir and well characteristics, as well as the properties of the fluids produced. Particular attention will be paid to the influence of the depth of the well on its productivity.

Keywords: Optimization, Production, Electric Submersible Pump (Esp), Reservoir, Flow Rate

1. Introduction

Exploitation of a hydrocarbon deposit contained in a reservoir consists of bringing it to the surface via a well. At the start of its operating life, the well generally produces eruptively, i.e. the reservoir pressure is sufficient to expel the effluent from the bottom to the surface (via the tubing) [1-3]. In addition to the reduction in the pressure of the fluids contained in the reservoir, a number of other factors can limit the recovery of hydrocarbons, including well drainage mechanisms, which are linked to the distribution of the permeability of the porous medium containing the oil around the well, the physical and chemical characteristics of the fluids and the rocks in which they are found, as well as very high pressure losses in the tubing (too large a diameter), and so on [1, 2]. The reduction in fluid pressure in the reservoir can be counteracted by using artificial lift systems, which fall into two main categories: pumping and gas lift. Pumping involves a wide variety of technologies, depending on the rheological characteristics of the oil produced and the well's potential flow rate (outrigger pumps and their derivatives, Moineau-type progressive cavity pumps, submersible hydraulic motor pumps and submersible electric motor pumps) [2-4].

Gas lift consists of lightening the weight of the column of fluid contained in the tubing by injecting gas into it through the annular space using a system of specially positioned valves. The fluids injected can be of different types, depending on the reservoir and its availability (water, natural gas, smoke). This injection requires the drilling of additional wells, which may be located on the periphery or within the reservoir. If we want to increase the final recovery, it is necessary to predict and monitor the evolution of the seabed between the different fluids [1-5]. The Liawenda 753 producing well in the Turonian reservoir is non-eruptive, meaning that the Turonian reservoir did not contain enough energy to lift the oil from the bottom of the well to the surface. To do this, the well had to be energetically assisted by activation. The Liawenda 753 production well is currently producing using the progressive cavity pump activation method. As we all know, there are a number of parameters in a well's production system that come into play to determine its performance (the size of the tubing, the depth of the well, the type of fluid to be produced, the pressure prevailing at the bottom of the well and in the reservoir, the temperature at the bottom of the well, the productivity index, etc.).

With this in mind, we're going to use the Hagedorn-Brown mathematical correlation to determine the evolution of pressure in the production tubing as a function of well depth. Since manual calculations are tedious, we will use the Hagedorn-Brown BHxls program. However, the use of the Progressive Cavity Pump (PCP) as a means of activation requires an upstream evaluation of its performance, considering a number of reservoir parameters, fluid properties and well properties. In order to obtain optimum pump performance, it is therefore necessary to convert the PCP pump into an electric submersible pump (ESP). It is for this reason that we have entitled our work: 'Study of the increase in production through the performance of the electric submersible pump (ESP) in the Liawenda 753 well'.

For this study, our concern revolves around questions such as:

• Is the Liawenda 753 well efficient and capable of producing a good flow?
• Is it possible to increase production from the Liawenda 753 well by using the ESP pump?
• Can the depth of the Liawenda 753 well influence its productivity?

Determining the performance of the Liawenda 753 well and adjusting the main parameters such as hydrostatic head, depth of pump installation, predicting the desired liquid flow, suction and discharge pressure, power, efficiency, pump installation depth and pumping height for the electric submersible pump as well as the productivity index with rigor would also allow to obtain optimal pump performance ESP in our study well.

1.1. Objectives

The general objective of the present work is to study the increase in hydrocarbon production in the Liawenda 753 well by changing from the progressive cavity pump (PCP) to the electric submersible pump (ESP).

To achieve this work, we have set the following specific objectives:

Presentation of the completion diagram of the Liawenda 753 well.

• Presentation of the production history.
• Presentation of PVT parameters.
• Determination of Liawenda 753 well performance.
• Increasing well production through the performance of the electric submersible pump.

2. Methods and Materials used

Our research was based on the technique of documentation and data collection from Pérenco-Rep. We also used a number of computer programs, including HagedornBrownCorrelation.xls (a program that shows the change in pressure in the production tubing as a function of depth), and Microsoft Excel 2016 (a program for making statistical calculations, drawing curves, etc.).

Presentation of the Liawenda Field

Liawenda is Perenco's largest onshore field in the Democratic Republic of Congo by area and liquid hydrocarbon accumulation (STOIIP).

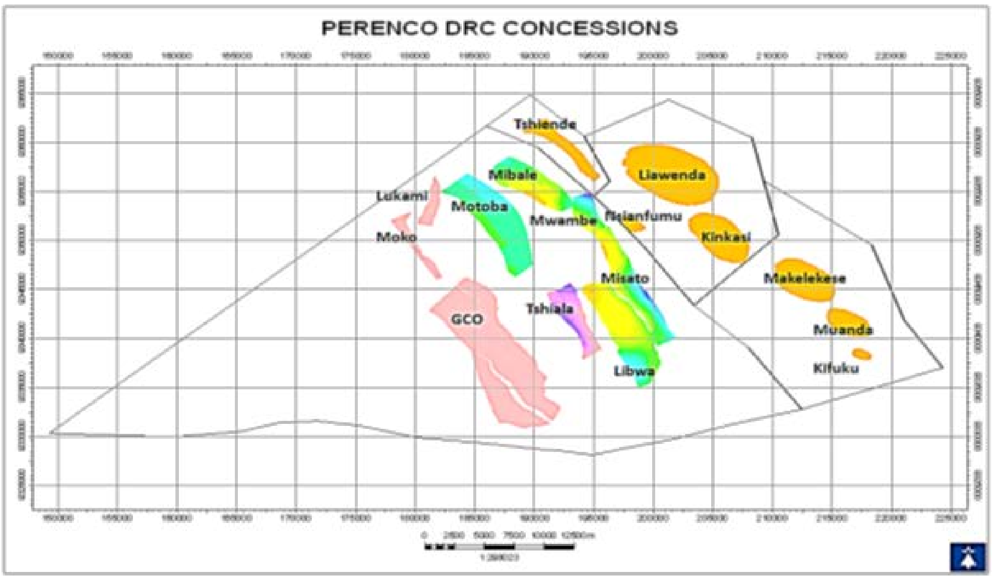

Figure 1: Geographical Location Map of the Liawenda Field [6].

The Liawenda field consists of two deposits, the Turonian on the upper part and the Cenomanian on the lower part, the Liawenda field covers 60 km^2 and currently has 197 producing wells. Of these, 102 produce in the Turonian reservoir (the average thickness of the reservoir is 30 m). The Turonian reservoir is contained in an anticline structure with no initial gas cap. This field is injected with water to maintain good pressure and sweep up the hydrocarbons. Water injection is done with 60 injection wells and more than 30,000 barrels of injected water per day currently. Oil production is declining and is now around 2400 BOPD (barrels/day) with a BSW of more than 90%. However, there are some areas of the Liawenda field that remain relatively less impacted by the injection, particularly the northwestern

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part that will be the subject of our study. This field has 220 wells drilled since its existence, including 160 producing wells, including wells that are shut down for many reasons, and 60 injection wells.

Coastal Basin Petroleum System

Source rocks

For the entire stratigraphic series of the Congolese onshore, geochemical studies have shown that:

• Congolese crude oil, regardless of its geographical, stratigraphic or structural position, comes from the pre-salt section, in particular from the Bucomazi formation, made up of black clays rich in organic matter from 2 to 30% TOC (Hydrocarbon type I) ;

• The post-salt sequence reveals levels of potential source rocks in the Iabe-Cretaceous and Iabe-Tertiary formations. These are marine clays rich in organic matter, mainly marine algae (type II and III hydrocarbons) [7].

Reservoir rocks

Almost all of the Congolese crude oil from the onshore and the field in particular comes from the post-salt reservoirs of Mavuma, Vermelha, Kinkasi and the Liawenda horizon, with an average porosity of 13 to 30% and an average permeability of 6 to 68 md. The basal sands of Lucula, the carbonates of Toca and the sands of Chela and Malembo are probable reservoirs, although they have not yet been produced in the onshore of the coastal basin. It should be noted here that these various near-salt reservoirs have been tested and put into production, some of them offshore the Congolese coast.

Cover rocks

In the onshore of the coastal basin, the impermeable, non-porous and plastic horizons that ensure the tightness of the reservoirs and protect the fluids against atmospheric destructive agents are:

• Loeme salt, for pre-salt tanks

• Clays and some thin evaporitic layers of Kinkasi, for the Vermelha and Mavuma reservoirs ;

• The clays of Iabe and Malembo, for the Liawenda and Kinkasi horizons [7].

Turonian Reservoir Properties

• Geology

In the stratigraphic series of the Congo coastal basin, the Turonian reservoir (the most exploited by Perenco) in the Liawenda field presents four types of facies from the point of view of its lithology : Siltstone, Limestone, vuggyLimestone and shales.

The Liawenda reservoir is very heterogeneous vertically. It is made up of six zones named from Z6 to Z1. The two extreme zones Z6 and Z1 are impregnated with water and the central zones Z2 to Z5 are impregnated with oil. Z4 and Z3 are the two main producing zones with the best petrophysical properties. Zones Z5, Z4 and Z3 are separated from each other by barriers formed by thin impermeable layers of clay. The porosity varies between 18 and 26% [8].

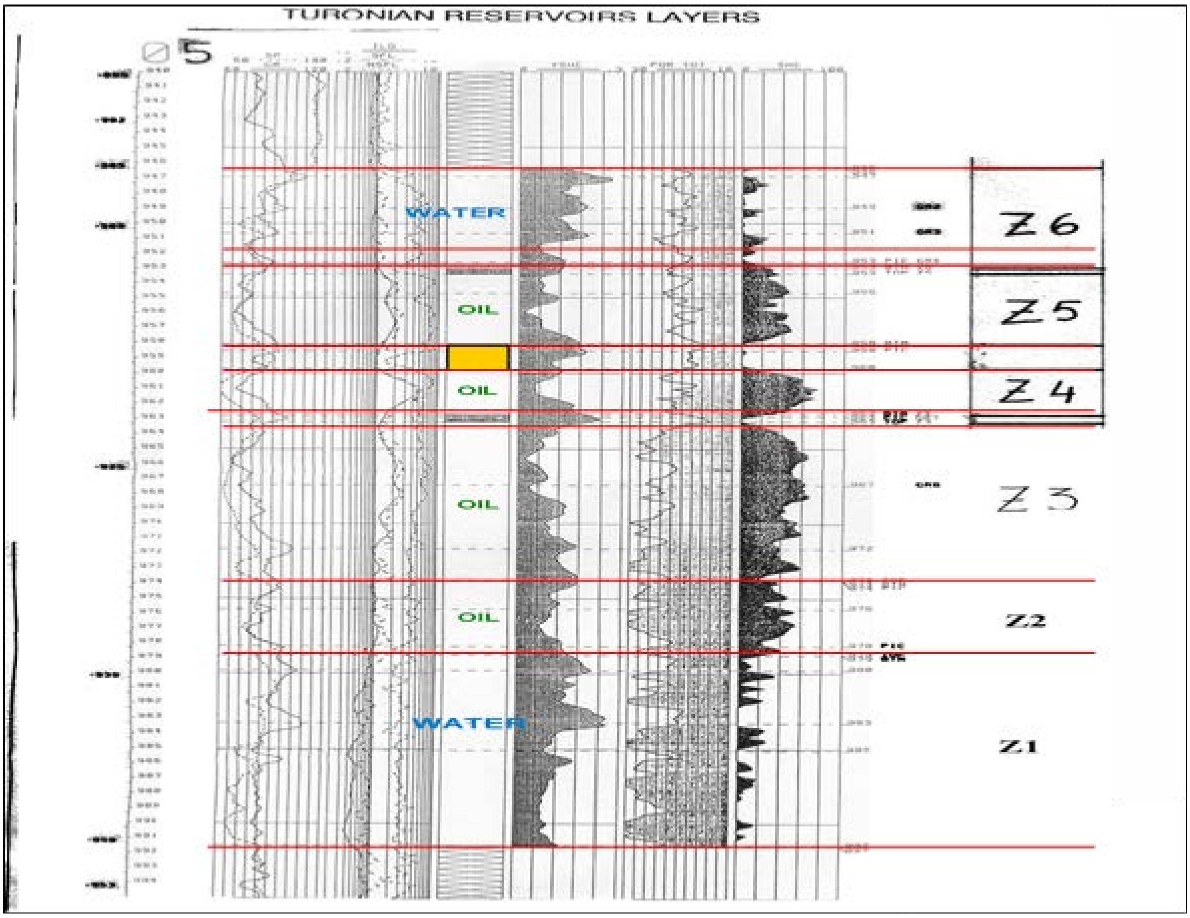

Figure 2 : Different Layers of Turonian Reservoir [8].

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Structure of the Turonian Reservoir

The Liawendas anticline extends over 60 km2 in an NNW-SSE direction, with a 30m-thick reservoir. Presentation of the diagram of the completion of the liawenda 753 well the diagram of the completion of the Liawenda 753 well, shows us through Figure 3 below, the well at a total depth of 1058 m (3470.24 ft) with two different diameter casings and one production tubing. Of which the first casing was placed at the depth of 409 m (1341.52 ft) with a diameter of 8.625 inch; The second production casing descended to a depth of 1056 m (3463.68 ft) with a diameter of 5.5 inch and the production tubing descended to a depth of 1058 m (3470.24 ft) with a diameter of 2.875 inch.

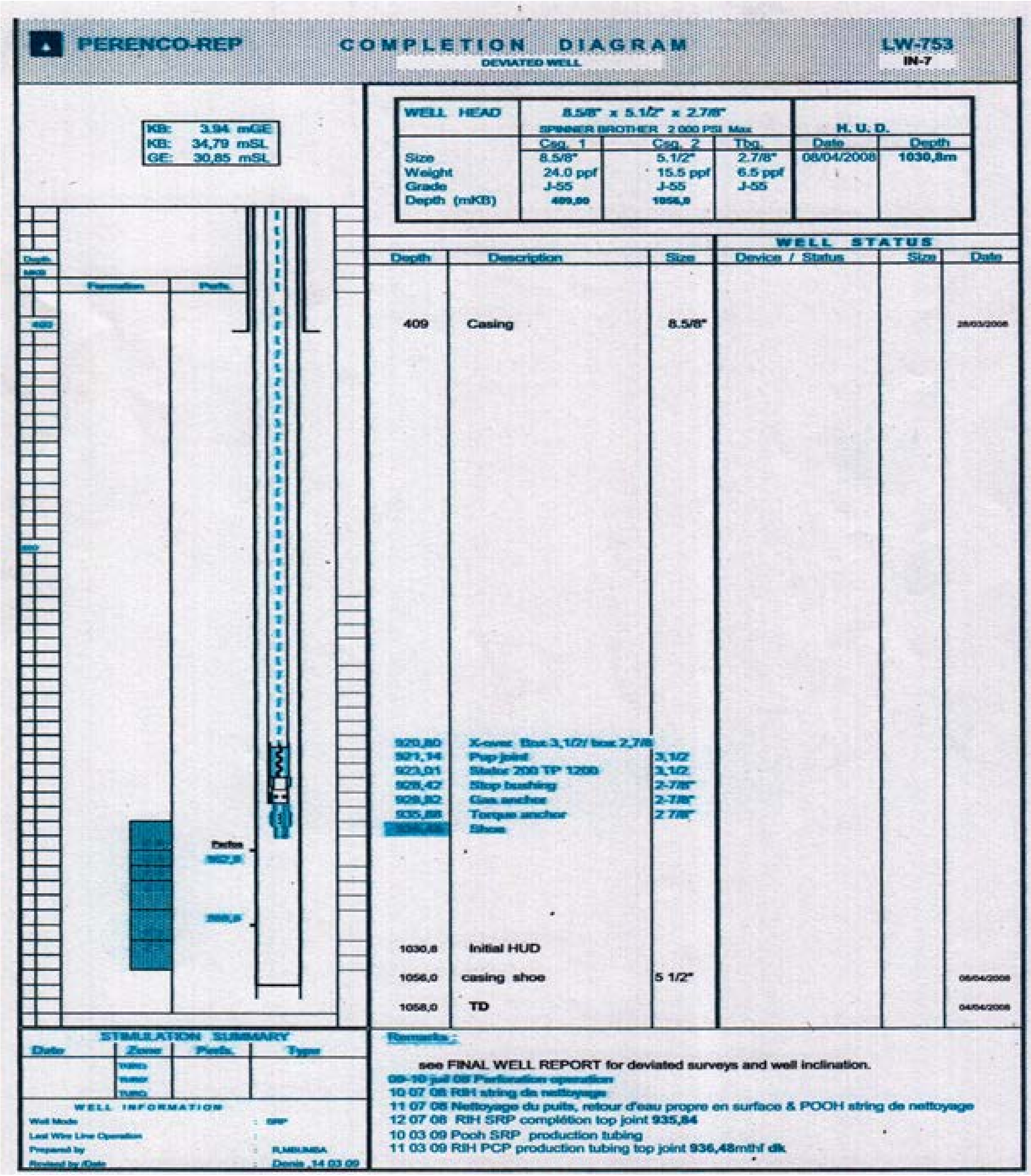

Figure 3 : Completion diagram of the Liawenda 753 shaft[9].

Pvt parameter presentation of liawenda 753 well.

Table 1: Below Represent Some Elements of the PVT Parameters of the Liawenda 753 Well and the Turonian Reservoir on the Liawenda Field Side.

Parameters	Value
Tank pressure (Pr)	1740 psi
Pression au point de bulle (Pb)	1520 psi
Bubble Point Pressure (Pb)	1215 psi
Temperature (Twf)	210 °F
Temperature (Thf)	63 °F
Dissloved Gas Ratio (Rs)	523 scf/stb
Oil viscosity (μo)	3.5 Cp
Density API	31 ° API
Volumetric Forming Factor (Bo)	1,235
Permeability (K)	12 Md
Porosity (Φ)	19 %
Thickness (H)	787,2 ft
Skin effect	0
Drainage Radius (r_e)	1355 ft
Well Radius (r_w)	1,4375 ft

Presentation of the Production History of the Liawenda 753 Well

The Liawenda 753 well is produced in pumped activation mode precisely by the progressive cavity pump (PCP). Table 2 below presents some production data from our study well. Of which we note that the production of the Liawenda 753 well swims around 350 BLPD with the percentage of water worth more than 80%.

Table 2: Liawenda 753 Well Production History of a Few Years [10].

DATE	ACTIV MODE	ACTIV DETAILS	ACTIV RATE	BLPD	BOPD	FW	MCFD	GLR TOTAL	GLR FORM	GOR
13/01/2019	PCP	200TP1200	260	400	12	97	10	25	25	862
25/01/2019	PCP	200TP1200	274	444	25	94	11	25	25	446
31/01/2019	PCP	200TP1200	274	437	27	94	10	23	23	371
06/02/2019	PCP	200TP1200	274	446	8	98	9	20	20	1176
13/02/2019	PCP	200TP1200	274	435	19	96	11	25	25	581
23/02/2019	PCP	200TP1200	274	428	30	93	11	26	26	366
07/03/2019	PCP	200TP1200	273	422	17	96	12	28	28	700
19/03/2019	PCP	200TP1200	275	425	17	96	11	26	26	650
25/03/2019	PCP	200TP1200	270	396	15	96	9	23	23	622
03/04/2019	PCP	200TP1200	270	406	25	94	9	22	22	355
21/04/2019	PCP	200TP1200	405	123	9	93	7	57	57	803
29/04/2019	PCP	200TP1200	269	471	46	90	11	23	23	235
14/05/2019	PCP	200TP1200	265	440	51	88	9	20	20	174
01/06/2019	PCP	200TP1200	275	448	32	93	11	25	25	352
11/06/2019	PCP	200TP1200	275	427	16	96	9	21	21	568
23/06/2019	PCP	200TP1200	265	450	15	97	12	27	27	794
10/07/2019	PCP	200TP1200	275	462	18	96	7	15	15	375
25/07/2019	PCP	200TP1200	280	426	28	94	9	21	21	323
04/08/2019	PCP	200TP1200	280	452	13	97	9	20	20	714
15/08/2019	PCP	200TP1200	280	426	28	94	9	21	21	323
20/08/2019	PCP	200TP1200	280	420	32	92	9	21	21	273

30/08/2019	PCP	200TP1200	280	463	14	97	9	19	19	633
12/09/2019	PCP	200TP1200	280	452	21	95	8	18	18	383
19/09/2019	PCP	200TP1200	280	439	19	96	9	21	21	477
27/09/2019	PCP	200TP1200	278	390	37	90	8	21	21	221
02/10/2019	PCP	200TP1200	278	424	34	92	8	19	19	238
18/10/2019	PCP	200TP1200	208	482	29	94	7	15	15	250
01/11/2019	PCP	200TP1200	335	503	15	97	8	16	16	533
16/11/2019	PCP	200TP1200	345	517	16	97	7	14	14	467
20/11/2019	PCP	200TP1200	360	491	17	97	7	14	14	412
11/12/2019	PCP	200TP1200	370	471	21	96	8	17	17	378
19/12/2019	PCP	200TP1200	375	459	26	94	7	15	15	268
01/01/2020	PCP	200TP1200	385	424	12	97	7	17	17	586
03/02/2020	PCP	200TP1200	397	343	21	94	7	20	20	333
11/02/2020	PCP	200TP1200	399	362	11	97	6	17	17	567
23/02/2020	PCP	200TP1200	399	372	15	96	6	16	16	410
14/03/2020	PCP	200TP1200	200	118	4	97	1	9	9	265
15/03/2020	PCP	200TP1200	250	203	4	98	1	5	5	250
16/03/2020	PCP	200TP1200	250	331	0	100	1	3	3	0
19/03/2020	PCP	200TP1200	355	589	28	95	6	10	10	208
21/03/2020	PCP	200TP1200	355	582	23	96	6	10	10	250
22/03/2020	PCP	200TP1200	356	519	17	97	8	15	15	455
28/03/2020	PCP	200TP1200	356	476	14	97	8	17	17	567
07/04/2020	PCP	200TP1200	375	517	16	97	7	14	14	467
29/04/2020	PCP	200TP1200	406	343	10	97	4	12	12	400
04/05/2020	PCP	200TP1200	406	355	0	100	5	14	14	0
12/05/2020	PCP	200TP1200	406	277	8	97	4	14	14	483
23/05/2020	PCP	200TP1200	406	379	9	98	4	11	11	440
05/06/2020	PCP	200TP1200	406	402	24	94	3	7	7	119
22/06/2020	PCP	200TP1200	406	322	6	98	1	3	3	150
30/08/2020	PCP	200TP1200	160	242	0	100	1	4	4	0
31/08/2020	PCP	200TP1200	240	416	0	100	1	2	2	0
03/09/2020	PCP	200TP1200	350	631	32	95	1	2	2	40
04/09/2020	PCP	200TP1200	310	544	11	98	1	2	2	100
05/09/2020	PCP	200TP1200	340	582	29	95	1	2	2	40
09/09/2020	PCP	200TP1200	360	652	26	96	4	6	6	150
18/09/2020	PCP	200TP1200	201	326	0	100	1	3	3	0
30/09/2020	PCP	200TP1200	290	510	41	92	9	18	18	225
11/10/2020	PCP	200TP1200	284	464	42	91	8	17	17	189
21/10/2020	PCP	200TP1200	275	438	13	97	6	14	14	483
27/10/2020	PCP	200TP1200	273	412	21	95	17	41	41	820
06/11/2020	PCP	200TP1200	265	411	29	93	9	22	22	314
19/11/2020	PCP	200TP1200	270	417	25	94	5	12	12	200
27/11/2020	PCP	200TP1200	290	456	23	95	5	12	12	240
01/12/2020	PCP	200TP1200	330	558	33	94	6	11	11	183
13/12/2020	PCP	200TP1200	330	537	32	94	8	15	15	250
19/12/2020	PCP	200TP1200	330	565	40	93	6	11	11	157
29/12/2020	PCP	200TP1200	340	503	25	95	7	14	14	280

05/01/2021	PCP	200TP1200	345	574	34	94	7	12	12	200
28/01/2021	PCP	200TP1200	350	597	42	93	6	10	10	143
12/02/2021	PCP	200TP1200	370	621	25	96	7	11	11	275
28/02/2021	PCP	200TP1200	380	597	30	95	8	13	13	260
07/04/2021	PCP	200TP1800	250	297	85	95	1	3	3	60
09/04/2021	PCP	200TP1800	250	294	97	71	1	3	3	75
14/04/2021	PCP	200TP1800	400	617	270	56	1	2	2	33
19/04/2021	PCP	200TP1800	400	587	150	74	3	5	5	83
30/04/2021	PCP	200TP1800	400	614	210	66	4	7	7	140
25/07/2021	PCP	200TP1800	210	289	121	58	1	3	3	42
26/07/2021	PCP	200TP1800	240	414	150	64	1	2	2	56
29/07/2021	PCP	200TP1800	210	316	130	59	1	3	3	73
31/07/2021	PCP	200TP1800	300	451	78	83	3	7	7	438
05/08/2021	PCP	200TP1800	300	489	243	50	3	6	6	122
09/08/2021	PCP	200TP1800	350	581	190	68	6	10	10	313
23/08/2021	PCP	200TP1800	370	542	210	61	6	11	11	282
29/08/2021	PCP	200TP1800	380	478	128	73	8	17	17	293
30/08/2021	PCP	200TP1800	360	401	171	57	0	0	0	0
23/10/2021	PCP	200TP1800	180	214	105	51	0	0	0	0
02/12/2021	PCP	200TP1800	145	414	205	50	0	0	0	0
07/12/2021	PCP	200TP1800	270	254	73	71	0	1	1	17
17/12/2021	PCP	200TP1800	145	168	63	57	3	18	18	486
19/12/2021	PCP	200TP1800	130	187	66	65	0	1	1	12
22/12/2021	PCP	200TP1800	110	173	77	55	3	17	17	395
24/12/2021	PCP	200TP1800	110	180	53	71	5	28	28	2000
28/12/2021	PCP	200TP1800	110	172	58	66	5	29	29	630
31/12/2021	PCP	200TP1800	100	152	68	58	3	20	20	400

Determining the Performance of the Liawenda 753 Well.

Concept of Productivity Index (PI) Calculation and Plotting Inflow Performance Relationship (IPR) Curves. The productivity index of a reservoir can be evaluated by equation (1) when the flow is monophasic.

$$J = \frac{q}{P_r - P_{wf}} \quad (1)$$

This index, when inverted, gives the slope of the IPR line, which is the Inflow Performance Relationship (IPR) curve. This curve characterizes the performance of the tank [11-14]. The IPR curve is constructed in the laboratory by the analytical or empirical formulas that govern the flow of oil to the well into which the characteristics of the reservoir are introduced. The flow of hydrocarbons into the reservoir can be done in one phase (liquid or gas) or several phases (liquid + gas).

The performance of the Liawenda 753 well would be known by the determination of its productivity index value, the flow rate knowledge at the pressure at the bubble point and the maximum flow rate when the downhole pressure is considered zero [15-19].

Determination of the Productivity Index of the Liawenda 753 Well.

As in the Turonian reservoir we consider the flow to be pseudo-permanent and since table (2) shows us the average pressure of the reservoir, we will use the relation (2) to determine the productivity index of the Liawenda 753 well.

$$J^* = \frac{q}{(\bar{P}-P_{wf})} = \frac{[illegible]}{[illegible]} \quad [2]$$

$$J^* = 2,53 \ stb/psi-d$$

After the calculation, we found the productivity index of the Liawenda 753 well with a value of 2.53 stb/psi-d, which is higher than 0.5 stb/psi-d which shows that our study well is really performing, capable of providing a good production throughput. Determination of flow rate at the bubble point of the Liawenda 753 well. The flow rate of hydrocarbons at the pressure at the bubble point and at the two-phase portion of the fluid flow are determined using the relationships (3) and (4) respectively.

$$Q_b = 2,53 \times (1740 - 1520) \quad [3]$$

$$Q_b = 556,6 \ stb/d$$

Hence the flow of hydrocarbons at the pressure at the bubble point is 556.6 stb/d

And the flow value of the hydrocarbons at the two-phase flow part is:

$$Q_v = \frac{2,53 x 1520}{1,8} \quad [4]$$

$$Q_v = 2136,44 \ stb/d$$

Determination of the Maximum Flow Rate of the Liawenda 753 Well.

As noted in the previous chapter, the maximum flow rate shall be determined at downhole pressure or Absolute Open Flow (AOF) using the relationship (5):

$$Q_{max} = 2,53(1740 - 1520) + \frac{2,53 x 1520}{1,8}[1 - 0,2\left(\frac{0}{1740}\right) - 0,8\left(\frac{0}{1740}\right)^2] \quad [5]$$

$$Q_{max} = 2693 \ stb/d$$

Hence the maximum flow rate in the Liawenda 753 well is 2693 stb/d when the downhole pressure is 0 psi. Knowing that it is impossible for a well to produce a maximum flow rate because atmospheric pressure always intervenes.

Plotting the Inflow Performance Relationship Curve for the Liawenda 753 Well.

As we currently know the maximum flow rate of the Liawenda 753 well, we will draw the Inflow Performance Relationship curve using the relationship (6) and simply varying the flow rate (Q) in the relationship (6) to obtain the different downhole pressure and flow pairs.

$$P_{wf} = 0,125\bar{p}\left[\sqrt{81 - 80\left(\frac{Q}{Q_{max}}\right)} - 1\right] \quad [6]$$

After the flow variation at the interval of 200 stb/d in relation (6) above, we had the different downhole pressure pairs and their corresponding flow rates presented in Table 3. below.

Table 3 : Downhole Pressure Couple Values and their corresponding flow rates

Flow Q in (stb/d)	Downhole pressure Pwf in (psi)
0	1740
200	1667
400	1591
600	1511
800	1428
1000	1340
1200	1247
1400	1148
1600	1041
1800	924
2000	793
2200	643
2400	460
2600	204
2693	0

These different values of downhole pressure couples and their corresponding flow rates allow us to draw the Inflow performance Relationship (IPR) curve of the Liawenda 753 well see Figure 5 below.

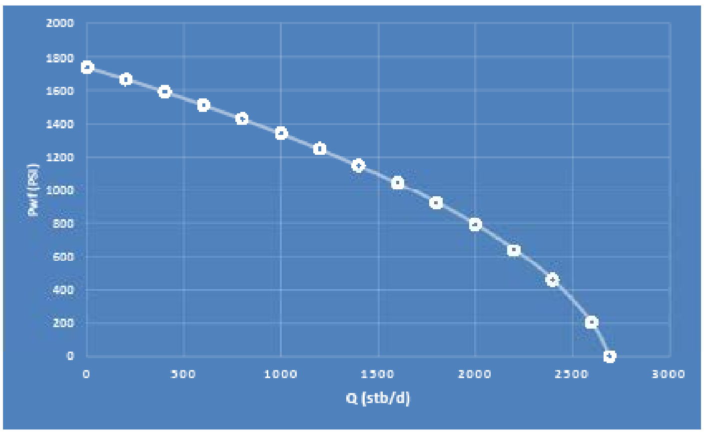

Figure 5: Inflow Performance Relationship curve of the Liawenda 753 well

The Inflow Performance Relationship curve in Figure 5 above shows the capable flow rates that the Liawenda well could produce as a function of downhole pressure. So, the curve tells us that to have the production 1200 stb/d, the pressure at the bottom of the well must be 1247 psi.

Increased Production Through esp Pump Performance

After a careful study of the Inflow Performance Relationship (IPR) curve characterizing the capacity of Liawenda 753 well to produce the fluid, we decided to apply some mathematical relationships to determine the performance of the electric submersible pump (ESP) in order to optimize the production of the current well.

Determination of Desired Liquid Flow (QLD)

Looking at the evolution of the current production of the Liawenda 753 well and looking at the performance of the current Liawenda 753 well to be able to produce, we have decided to take a desired liquid flow rate of QLD = 1000 stb/day which corresponds to a downhole pressure of 1340 psi according to the Inflow Performance Relationship (IPR) curve in Figure 5. So, we would like to point out that it is advantageous to convert the desired liquid flow rates (QLD) by the production into the liquid flows that arrive at the pump at the bottom of the well by the relationship:

$$Q_{LD} \times B_0 = 1000 \times 1{,}235 = 1235 \text{ stb/day} \quad [7]$$

Hence the electric submersible pump (ESP) must have the capacity to produce a flow rate of 1235 stb/day.

Determination of Downhole Pressure (Pwf)

As in the previous section we determined the desired liquid flow rate to be produced, it is very important to determine the corresponding downhole pressure (PWF) of the flow rate of 1235 stb/day using the Inflow Performance Relationship (IPR) curve by the formula below:

Production Through esp Pump Performance

After a careful study of the Inflow Performance Relationship (IPR) curve characterizing the capacity of Liawenda 753 well to produce the fluid, we decided to apply some mathematical relationships to determine the performance of the electric submersible pump (ESP) in order to optimize the production of the current well.

$$P_{wf} = 0{,}125\bar{P}\left[\sqrt{81 - 80\left(\frac{q}{q_{max}}\right)} - 1\right] \quad [8]$$

$$P_{wf} = 0{,}125 \times 1740\left[\sqrt{81 - 80\left(\frac{1235}{2093}\right)} - 1\right]$$

$$P_{wf} = 1230 \text{ psi}$$

Determination of the Pump Installation Depth (DPUMP)

The minimum depth at which the electric submersible pump (ESP) (DPUMP) would be placed is determined by the following relationship:

D_pump=D-(p_wf-p_suction)/ (0.433d_L)

D_pump : Pump installation depth;

D: Total depth of the well;

p_wf: Pressure at the bottom of the well corresponding to the desired liquid flow;

p_suction: Suction pressure of the pump on the weak side;

d_L: Liquid density. [18, 20]

And after study, we consider the suction pressure of the pump to be p_suction=300 psi

$$D_{pump} = 3470{,}24 - \frac{1230-300}{0.433d_L} \quad [9]$$

$$\text{Or } d_L = \frac{141.5}{131.5+°API} = \frac{141.5}{131.5+81} = 0{,}67$$

$$\text{D'où } D_{pump} = 3470{,}24 - \frac{1230-300}{0.433 \times 0.67}$$

$$D_{pump} = 1002 \text{ ft} \quad \text{is the installation depth of the pump}$$

Note: As we have determined the minimum depth at which the pump can be placed, if the suction pressure is 300 psi. Therefore, it is not recommended to place the pump at the minimum depth because in the event of a random drop in the liquid level in the well, the pump and its suction device would be above the liquid level, which would cause damage, such as cavitation for example [18, 20 ;2].

With that, we place the pump at a depth of 200 ft above the upstream end of the production tubing

$$D_{pump} = D - 200 \quad [10]$$

$$D_{pump} = 3470{,}24 - 200$$

$$D_{pump} = 3270{,}24 \text{ ft}$$

Since there has been a change in the depth at which the pump will be placed, we must calculate the suction pressure again by the following rearrangement equation:

$$P_{suction} = P_{wf} - (D - D_{pump}) \times (0{,}4329 \times d_L) \quad [11]$$

$$P_{suction} = 1230 - (3470{,}24 - 3270{,}24) \times (0{,}4329 \times 0{,}67)$$

$$P_{suction} = 1155 \text{ psi}$$

Determination of the Pressure Evolution in the Tubing

As far as the calculations of the evolution of the pressure in the tubing are concerned, we will use the computer program "HagedornBrownCorrelation.xls", which gives us the evolution of the pressure as a function of the depth of the well. Table 4 below shows the values of the pressure-depth pairs.

Table 4: Liawenda 753 Well Pressure-Depth Evolution Spreadsheet.

HagedornBrownCorrelation.xls					
Description: This spreadsheet calculates flowing pressures in tuning string based on tubing head pressure using Hagedorn-Brown Correlation.					
Instruction: 1) Select a unit system; 2) Update parameter values in the Input Data section; 3) Click "Slotion" button; and 4) View result in the Solution section and charts.					
Input Data		US Field Units	**1**	SI Units	**0**
	Depth (D):	3 470	ft	**3000,00**	**m**
	Tubing inner diameter (dti):	2,875	in.	**0,0500**	**m**
	Oil gravity (API):	31	oAPI	**0,80**	**S.G.**
	Oil viscosity (cp):	3,5	cp	**0,0020**	**Pa-s**
	Production GLR (GLR):	275	scf/bbl	**50**	**sm3/m3**
	Gas specific gravity (gg):	0,7	air =1	**0,709**	**air =1**
	Flowing tubing head pressure (phf):	200	psia	**5,00**	**MPa**
	Flowing tubing head temperature (thf):	63	oF	**80,00**	**Oc**
	Flowing temperature at tubing shoe (twf):	125	oF	**90,00**	**oC**
	Liquid production rate (qL):	1235	stb/day	**300,00**	**sm3/day**
	Water cut (WC):	50	%	**0**	**%**
	Interfacial tension (s):	20	dynes/cm	**0,030**	**N/m**
	Specific gravity of water (gw):	1,05	H2O=1	**1,076**	
Solution					
	Depth			**Pressure**	
	(ft)	**(m)**		**(psia)**	**(MPa)**
	0	**0**		**200**	**1,36**
	120	**36**		**214**	**1,45**

	239	73		227	1,55
	359	109		242	1,64
	479	146		256	1,74
	598	182		271	1,84
	718	219		286	1,94
	838	255		301	2,05
	957	292		316	2,15
	1 077	328		332	2,26
	1 197	365		348	2,37
	1 316	401		364	2,48
	1 436	438		381	2,59
	1 556	474		397	2,70
	1 675	511		414	2,81
	1 795	547		431	2,93
	1 915	584		448	3,05
	2 034	620		465	3,16
	2 154	657		482	3,28
	2 274	693		500	3,40
	2 393	730		518	3,52
	2 513	766		536	3,65
	2 633	803		554	3,77
	2 752	839		573	3,90
	2 872	876		592	4,02
	2 992	912		610	4,15
	3 111	949		629	4,28
	3 231	985		649	4,41
	3 351	1 022		668	4,54
	3 470	1 058		688	4,68

And the latter gives us torques (pressure – depth) allows us to plot the curve of the evolution of the pressure in the tubing presented in Figure 3.3 below.

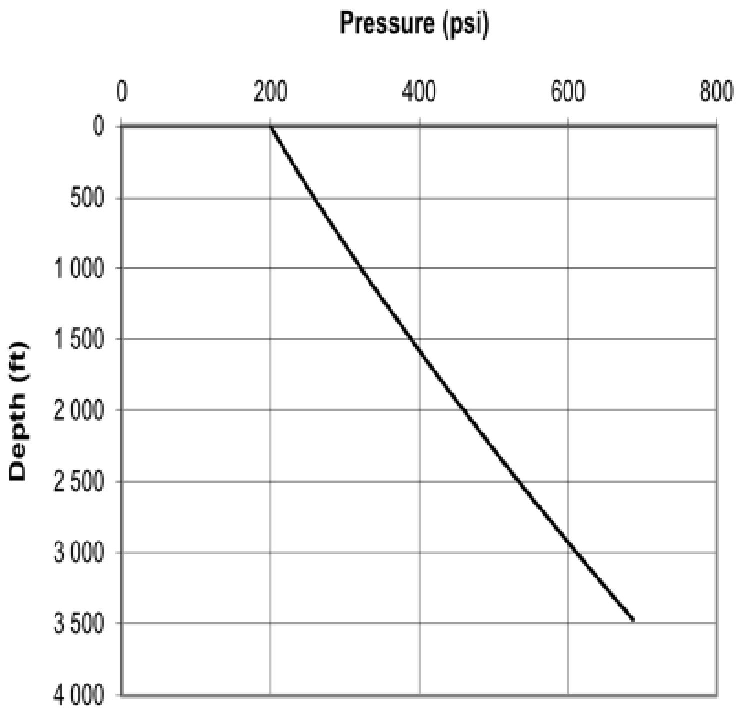

Figure 6: Curve of the Pressure Evolution in the Tubing as a Function of the Depth of the Liawenda 753 Well with (3470.24ft; 688 psi).

This curve clearly shows us that it takes a pressure of 688 psi to get the oil to the wellhead, that is to say downstream of the Duse and if the pressure at the wellhead is set at 200 psi, while the suction pressure of the pump when it is at the depth of 3270.24 ft is 1155 psi, then the pressure differential ΔP that remains and that the pump must be able to overcome is:

$$\Delta P = 1155\ psi - 688\ psi$$

$$\Delta P = 467\ psi$$

By calculating the pumping height by the relation below

$$h = \frac{\Delta p}{0.433} \quad [12]$$

$$h = \frac{467}{0.433}$$

$$h = 1079\ ft$$

The ESP pump caracteristics curves show that for the desired flow rate of 1235 stb/day, the best efficiency of a 60-stage electric submersible pump (ESP) is at a height of 7500 ft. This is 125 ft per floor. So, to raise the oil to 3270.24 ft, you need an ESP of 1079 ft/125, or 9 stages [18-20; 2]. The ESP pump carracteristics curves also show that for the desired flow rate of 1235 stb/day, the best efficiency of a 60-stage ESP pump is at a power of 400 hp. This makes 6.66 hp per floor. So, for a 9-stage ESP, you need a 6.66 x 9 = 60 hp electric submersible pump (ESP) [2].

3. Conclusion

We have decided to develop the various techniques and methods to optimize the production of oil and gas that is in the reservoir at depth and in the well. On this, we determined the performance of the Liawenda 753 well producing in the Turonian reservoir whose productivity index found is (IP = 2.53 stb/d-psi) which is well above 0.5 which really shows that the reservoir/or well is very efficient capable of giving a good fluid production. The latter gives the flow rate at the bubble point of a value of 556.6 stb and the maximum flow rate of 2693 stb/d. Then, based on some technical criteria, we studied and determined the performance of the electric submersible pump by giving the desired liquid flow capacity of 1235 stb/d lifted to a height of 3270.24 ft with a pump efficiency of 9 stages and a power of 90 hp.

Determining the performance of the Liawenda 753 well and adjusting the main parameters such as hydrostatic head, depth of pump installation, predicting the desired liquid flow, suction and discharge pressure, power, efficiency, pump installation depth and pumping height for the electric submersible pump as well as the productivity index with rigor would also allow to obtain optimal pump performance ESP in our study well. Thus, it is clear that much more satisfactory results are obtained than using the Electric Submersible Pump (ESP) than the Progressive Cavity Pump (PCP) for this Liawenda 753 well.

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