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Use of Excel Worksheet for the Selection of an Electro-Submersible Pump

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Abstract

The present papers evaluate the employment of a sheet calculation of Excel for the design and selection of an electro submersible pump as method of artificial lift for any selected well, preferably of reservoirs whose mechanism of production is by Water Encroachment that meets certain conditions such as: low GLR, high I.P; preferably taking well test data at the beginning or at any time in its production stage, to be able to determine the optimum flow rate to produce the well with the installed pump.

For contrast to our results, we took the information from a reservoir that we called "FIP" in which this artificial lift system is currently used and we verify that the results are very close to the results of the real tests carried out on wells in this reservoir.

It makes use of the Excel program for the calculations because this is a very widespread, easy and common use of most of the engineering students.

With a good use of the Excel worksheet for the implementation of the electro submergible pump we can choose a pump with its number of stages necessary, engine power required and its protector, and thanks to that we can choose among more than one bomb depending on the case so that you can reduce the cost of production and to optimized well production

Introduction

Usually, a well flows naturally at the beginning of its productive life; during this time the pressure of the reservoir provides sufficient energy to raise fluid until the surface. In this case it is said that the well is upwelling. Over time the pressure drops to a point where its value will not be enough to lift production to the surface, or optimize its lifting. At that moment it becomes necessary to install an artificial lift system. Currently we have several systems of artificial lift, one of these systems is the Electro Submersible Pump, which constitutes operating a centrifugal pump driven by an electric motor which prints the fluid enough energy to reach the surface.

This method was started in Venezuela, its technique to design this installation is to select a pump that meets the desired production requirements, and then to choose a motor capable of maintaining lifting capacity and pumping efficiency. This system is the most automated and easy to improve, although it is made up of complex and expensive equipment.

The Electro Submersible pumping system is widely used in certain oil fields located in the Peruvian jungle whose reservoirs present favorable conditions for the application of this method of artificial lifting.

Method of artificial lift for electro submersible pumping (BES)

The electro submersible pumping system (BES), is a system of artificial lift that uses electric power, which makes it operate a motor which in turn moves a pump centrifuge that it can raise a column of fluid from a level determined to the surface, downloading at a certain pressure.

BES generally has a range of capacities ranging from 200 to more than 10000 BPD, works at depths between 12,000 and 15,000 feet, the range of efficiency is between 18 to 70% and can be used in both vertical and biased wells here are some advantages and disadvantages:

Advantages:

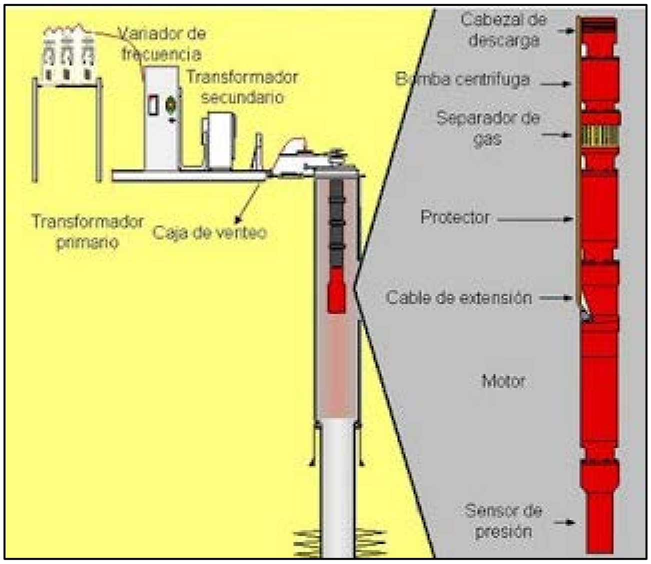
- Can be installed in remote locations and for its high level of automation requires supervision not necessarily face-to-face.
- Can raise high volumes of fluid.
- Handle high water cuts.
- Long life of equipment.
- This type of installation is not high impact to surrounding areas.

Disadvantages:

- High initial investment requires a lot of precision in the design.
- It is not profitable in wells of low production.
- Pumps and motor are susceptible to failure.
- It is not recommended in wells with high gas production.
- Electrical power is essential, requires high voltages.

A typical unit of BES is formed at the bottom of the well by components: electric motor, protection, input, centrifugal electro pump and lead section. The superficial parts are: head, surface cable, control panel, inverter frequency and transformer. Furthermore, include all the accessories necessary to ensure good operation; for example, a gas separator, if gas production passes the limits.

Once the pumping electro submersible unit has been put into operation, monitoring, recording and analyzing parameters must be started to check if the first design is optimal or certain modifications must be made, these data will also be used to later calculus in subsequent installations.



Graph 1. Components of a BES tipical.

Discussion

1. The BES works very well in the following cases:
   - High rate of productivity.
   - High or low pressure of bottom.
   - High ratio water-oil.
   - Low ratio gas-liquid.

In some cases, can present is problems, for example, a high ratio of gas-liquid generated problems mechanical in the team (life useful of the pump very short).

2. It is very important to keep in mind that reservoirs by water drive, such as wells in the Peruvian jungle, a relevant pump position must be handled in order to control and delay the water conification for as long as possible.
3. For the calculation of the loss of friction in the pipe was used the formula of Hazen Williams for a new pipe, this equation differs very little from the graph of loss of friction in pipe.
4. When the reservoir pressure is lower than the bubble pressure we have a biphasic (liquid-gas) flow with which we use the Vogel equation to calculate the flow rate that we want to pump in addition this equation considers a damage factor equal to Otherwise, when the reservoir pressure is greater than the bubble pressure the Darcy equation will be used.

Application

Desing of an Electro Submersible pumping system

- **Data Recopilation**

Description of Production Casing	7", N80, 20lb/ft	
Base of Production Interval	8800	ft
Top of Production Interval	8700	ft
Deviation Angle (°)	0	
Bubble Pressure (Pb)	2000	Psi
Static Pressure (Ps)	1900	Psi
Submergence	1000	Ft
Position of the pump over the top of the producer interval	100	Ft
Separator Pressure (Psep)	100	Psi

- **Production Test**

Q	**Pwf**
1455	180
1200	720
705	1260

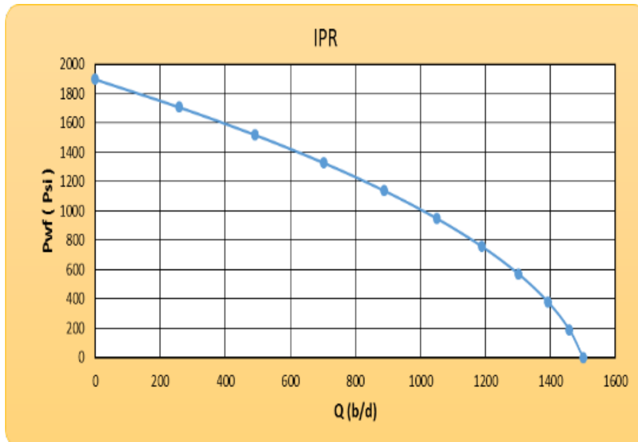
- **Development:**

	MD (ft)	**TVD (ft)**
Top of Production Interval	8700	8700
Base of Production Interval	8800	8800
Middle Point of Prod. Interval	8750	8750
Position of the pump over the top of the producer interval	100	100
Submergence	1000	1000
Pump depth	8600	8600
Depth of pump	7600	7600

- **Determination of Qmáx., using Vogel Equation:**

q	**Pwf**	**Pr**	**Pwf/Pr**	**Qmáx**
1455	**180**	**1900**	**0.0947368**	**1494.0353**
1200	**720**	**1900**	**0.3789474**	**1482.7086**
705	**1260**	**1900**	**0.6631579**	**1367.483**

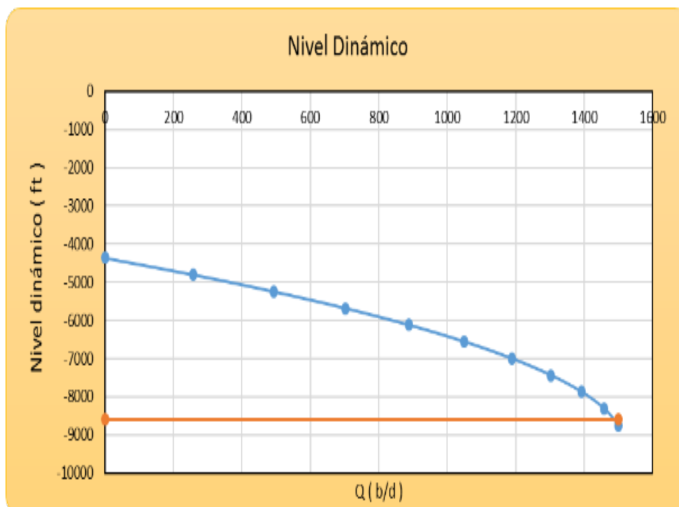
Pr	Pwf/Pr	Pwf	Q
1900	1	1900	0
1900	0.9	1710	258
1900	0.8	1520	492
1900	0.7	1330	702
1900	0.6	1140	888
1900	0.5	950	1050
1900	0.4	760	1188
1900	0.3	570	1302
1900	0.2	380	1392
1900	0.1	190	1458
1900	0	0	1500



Graph 2. Building of the IPR.

- **Determination of the Q Optimum (Qo):**

Q	Pwf	Nivel D.
0	1900	-4362
258	1710	-4800.8
492	1520	-5239.6
702	1330	-5678.4
888	1140	-6117.2
1050	950	-6556.0
1188	760	-6994.8
1302	570	-7433.6
1392	380	-7872.4
1458	190	-8311.2
1500	0	-8750

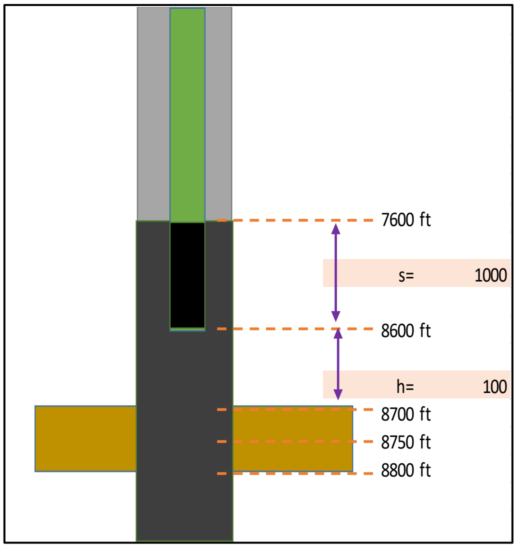


Graph 3. Determination of the Q optimum.

- Selection of the pump:

For Casing 7´´

Type	Y 62 B	
Head/stage	39.5	Ft
HP/stage	1.0	Hp



Graph 4. Dynamic conditions to determine the total dynamic height

Results

#stages	200	
HP required	**200**	**Hp**

Conclusions

The conclusions from this study are presented herein:

- The results obtained are a first design for a well with certain characteristics, later this design will be modified as the production of the well develops and the original conditions change.
- It is necessary to take into account that the design and application of the Electro Submersible system will be good and reliable depending on the data used for its design, in this case, well test data.
- Once an electro submersible pumping unit has been commissioned, parameters must be monitored, recorded and analyzed under normal operating conditions and thus a very useful reference point will be available to prevent abnormal operating conditions and to take corrective measures.
- Calculations were performed using a water gradient value (0.433 psi/ft) instead of a gradient of the oil / water mixture, because the water gradient is a more extreme case for securing the fluid column lift That will perform the pump.
- Considerations of submergence and depth of the pump will be taken at the discretion of the designer taking into account data from neighboring wells in addition to being able to delay the water coning and avoid problems of the Sanding of Oil Wells.
- When the gas volume exceeds 10% by volume, it is necessary to install a gas separator.

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