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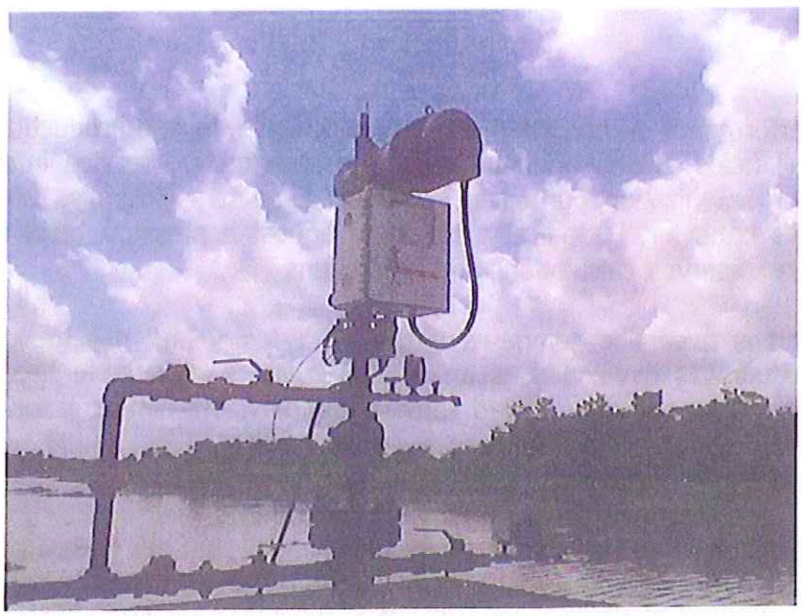
Evaluation of Direct Drive Head's Smartpumper of Well 29Ow05 at the Calcutta Field Operation (CFO)



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Objective

1. Evaluate DDH's smartpumper ease of use, performance , Quality Control and online web based automation.
2. Compare and make an economic evaluation of DDH's smartpumper performance with previously installed well head system
3. Evaluate, analyze and monitor DDH's smartpumper data transfer and automation.

Background

Currently well performance is monitored on a monthly base, by the Production Engineers (PE) in the respective oil fields, based on flow tests, pressure tests , service information and other historical data for optimization purposes. Reservoir Engineers (RE) also use pressure data to monitor the well's behavior. Periodically the RE's request a pressure build test on oil wells to perform necessary reservoir calculations and predictions

Direct Drive Head is a service company in the oil industry and has designed an automated pumping device that was developed as an economic low cost variable speed lifting option for progressive cavity pump operation called "Smart Pumper". The smart pumper can provide real time surface & subsurface measurements such as: FBHP, FBHT, RPM, etc , which can be accessible at the desktop without operators' intervention.
The RE's can also monitor their pressure surveys real-time at their desktop and can immediately observe any discrepancies and be able to abort lengthy well shut-in's before significant production losses are realized. They can also make real-time adjustments to the programmed schedule of build-up and drawdown tests that can minimize the associated production loss.

Analyses of the results

1. *Picture 1* shows the user friendly dashboard of well 29Ow05 web based graphical interface which can be accessed from any computer once the proper user name and password have been granted to specific uses. With this interface the user that can either have read or administrator's access at a glance. In case of read access the user can only see the information shown on the dashboard without performing any modification. This information includes having access to all the available data and with this perform a direct focused monitoring on the well at a glance. According to *Picture 2* of the annexes in a matter of seconds graphs can be made to make a well analyses in time.
2. Administrators' access to the online web based user friendly Smart Pumper interface is unique and should only be for users with privileges to make necessary changes after agreement with all the stakeholders of the respective wells! In case changes are made, then these are recorded in an On-line Log Report for future references. There is generally a delay when executing a command from the user desktop to the Smart Pumper's Console in the Calcutta Field from 0 to 38.8 seconds which is purely based on the internet connection speed when sending the command from the desktop to the smart pumper. Tests conducted by shutting the pump On and Off remotely as well as increasing the RPM show a variety of signal response. *(See Graph 2)*
   E-mail as well as automated SMS can be programmed in case there is an upset in the well.
3. In *Picture 2* it is noticeable that primary log parameters can be retrieved from the well, such as FBHP,FBHT ,Volt, Hz, amps & RPM as well as secondary log parameters like torque, theoretical flow and Fluid Level .Data transfer is submitted via a telephone signal from the smartpumper hardware in the CFO to the online Server in Houston of the Direct Drive head company.
4. *Table 1* shows a cost comparison between the current installed drive head and Direct Drive Head's smart pumper, which is $ 16544 cheaper
5. With the Smart Pumper installed on well 29Ow05 there is a 0.85 BOPD increase compared to the prior 10 months before its installation at similar production level. *(See Graph 1 and table 2 of the Annexes)*
6. The control of the fluid level via the Variable Frequency Drive (VFD) linked to the smart pumper's Proportional Integral Derivative (PID) controller is quite smooth. The point from which there is a perturbation until this is corrected to the target level programmed in the smart pumper controller takes about 10 days *(See graph 3).* In this graph can be clearly noticed that at 25 May 2011 12:02 am the target fluid level in the annulus suddenly decreased to almost 0ft and smoothly and gradually controlled by increased pump speed until the target level of 780 ft was reached on 4 June 2011 5:51 am.
7. Graph 4 shows that the data retrieved from the online dashboard of well 29Ow05 is repeatability within the 6 sigma (standard deviation) band.

Other issues

During the operational time of the smartpumper there were no maintenance issues that hampered the functionality of the smart pumper. A 100% uptime was registered for period of 6 months. The only issues is that the stuffing box leaks and the proper packing needs to be installed to eliminate this issue. Replacement of the gearbox will also take place within one month time , because of the water penetration via the upper seals. This is done because the bearings in gearbox are emanating a noise.

Conclusions

1. The Smartpumper system of the Direct Drive Head Company is user friendly and once installed virtually immediately transfer the data to the online server in Houston within an average of 9.23 seconds per signal or data point.
2. With the Smart pumper installed a direct focused monitoring and control is done per well or group of wells from a desktop or mobile phone from anywhere in the world which can result in reduction in travel time of the field operators to the wells , save traveling costs and increase the operators productivity
3. Control of the fluid level from 0ft to target level of 780ft is done in 10 days as per programming in the smart pumper's PID controller.
4. Eliminate unnecessary operators or production engineering intervention with regard to well optimization
5. The smart pumper system compared to the current installation is much cheaper
6. Data retrieved from the FBHP sensor is in statistical control for stable operational time, meaning that the installed down hole pressure sensor in the well is working properly

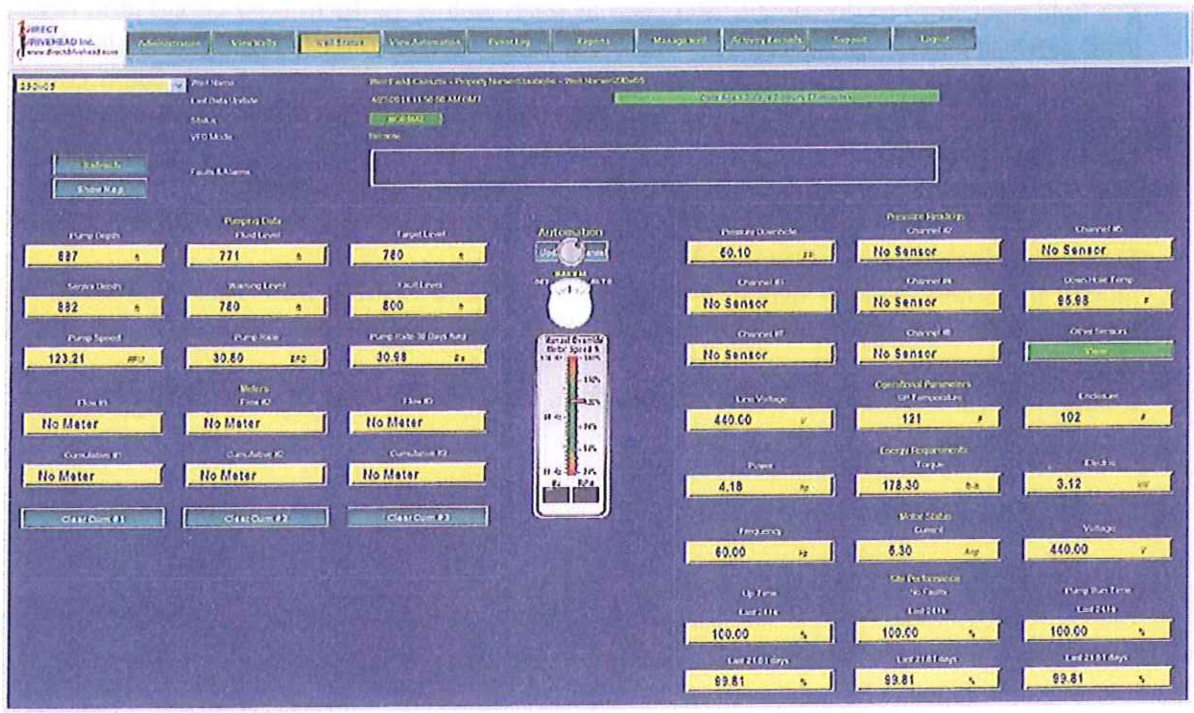
Recommendations

1. Increase the Staatsolie Maatschappij Suriname N.V. internet bandwidth, so that the smartpumper response is immediate for future desktop operators. Implement on all wells with a production of 50 BOPD and more, so that immediate actions, troubleshooting, analyses, optimization or learning can take place. This will eliminate the time needed for the field operators to download SRO data at each well or perform time consuming Acoustic Well Analyses AWA or Echom eter for Fluid level measurement. With the Digial AWA or Echometer there is no control over dependent variables such as water cut, foam content , sonic response, Density of gas and gas composition which can result in inaccurate fluid level measurements
2. Reduce the manpower per field in ratio with the installed smart pumpers
3. Install a local server and desktop based software package for desktop control operators Staatsolie Maatschappij Suriname N.V
4. Modify the smart pumper design and install the VFD 10 ft away from well 29Ow05 in order to cope with the Staatsolie Maatschappij Suriname N.V safety regulations for fire and explosion hazards.
5. Install a power backup for the smart pumper's controller in case of power failures.

Annexes

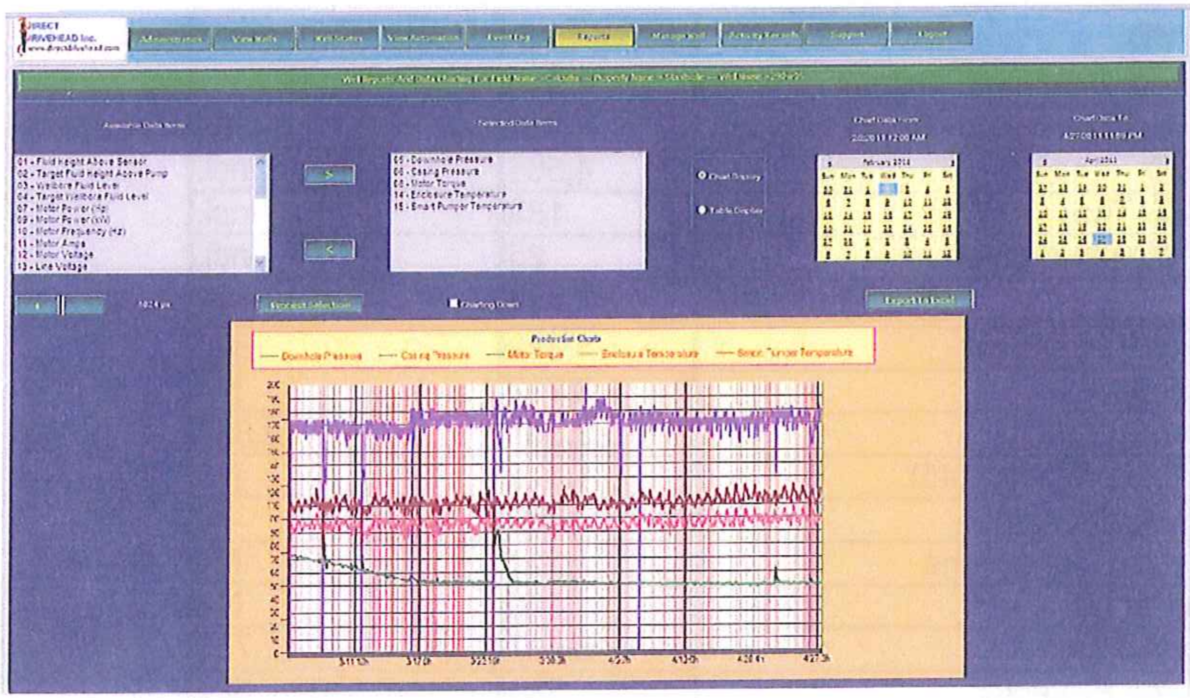
Annex 1

Picture 1 : DDH's smartpumper online dashboard interface for the well 29OW29



Annex 2

Picture 2 : Well 290W29 performance trough graphical analyses bases on online web based data



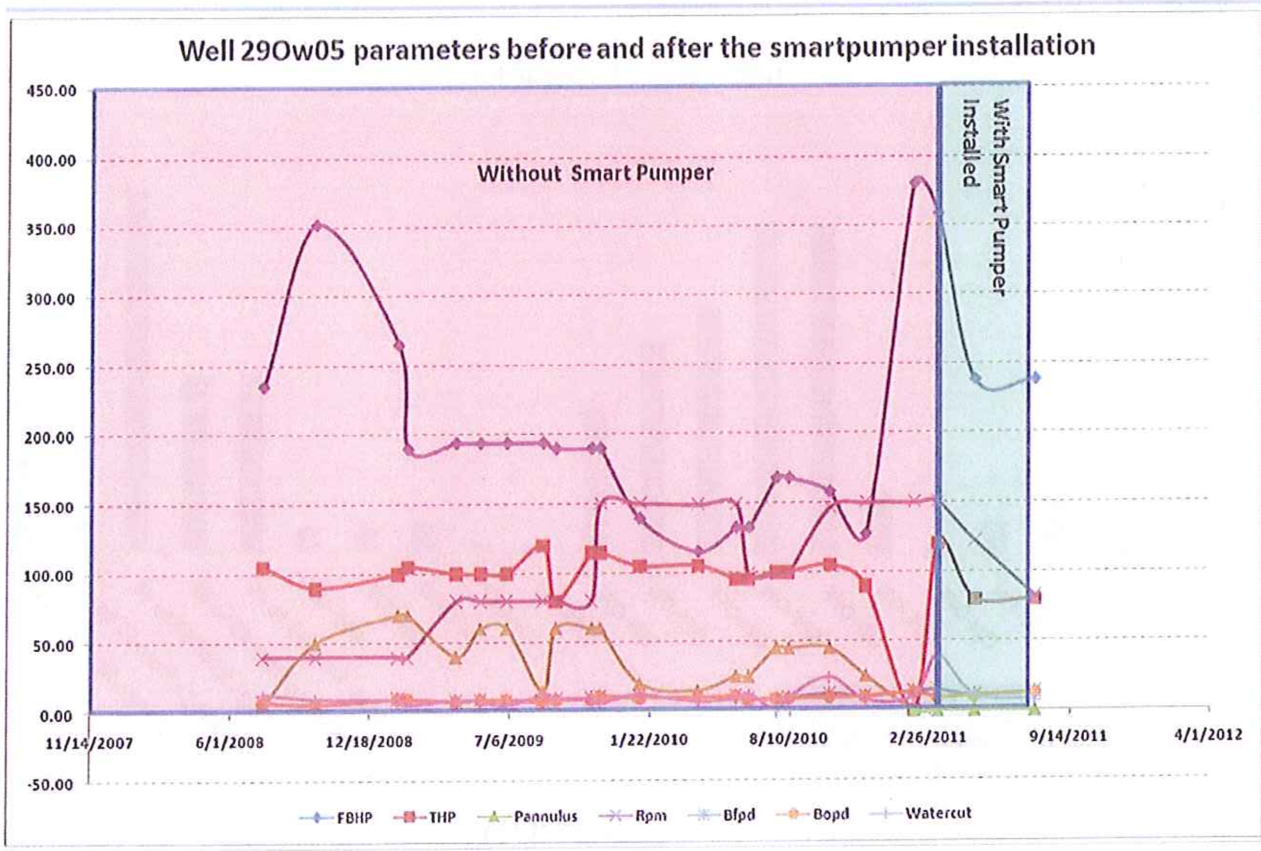
Annex 3

Table 1 : Cost Comparison Existeng vs. DDH's Smartpumper

Item	Existing	SmartPumper
Direct Drivehead (Inline)	7,555	
Direct Drivehead (Rt Angle)	NA	10,450
VFD	4,565	Incl.
Flow Tee	185	Incl.
3" Hammer union	25	Incl.
SubTotal	**12,330**	**10,450**
Pressure sensor	4,322	800
Carrier	2,712	NA
Cable (1350')	3,308	3,834
Cable protector (45)	1,575	NA
Cable Strap (45)	900	90
Cable Connections	314	NA
Smart Kit	400	NA
Datalogger	8,607	2,750
Surge Protector	584	584
SubTotal	**22,722**	**8,058**
TOTAL	**35,052**	**18,508**

Annex 4

Graph 1: Well 29Ow05 parameters before and after the smartpumper installation



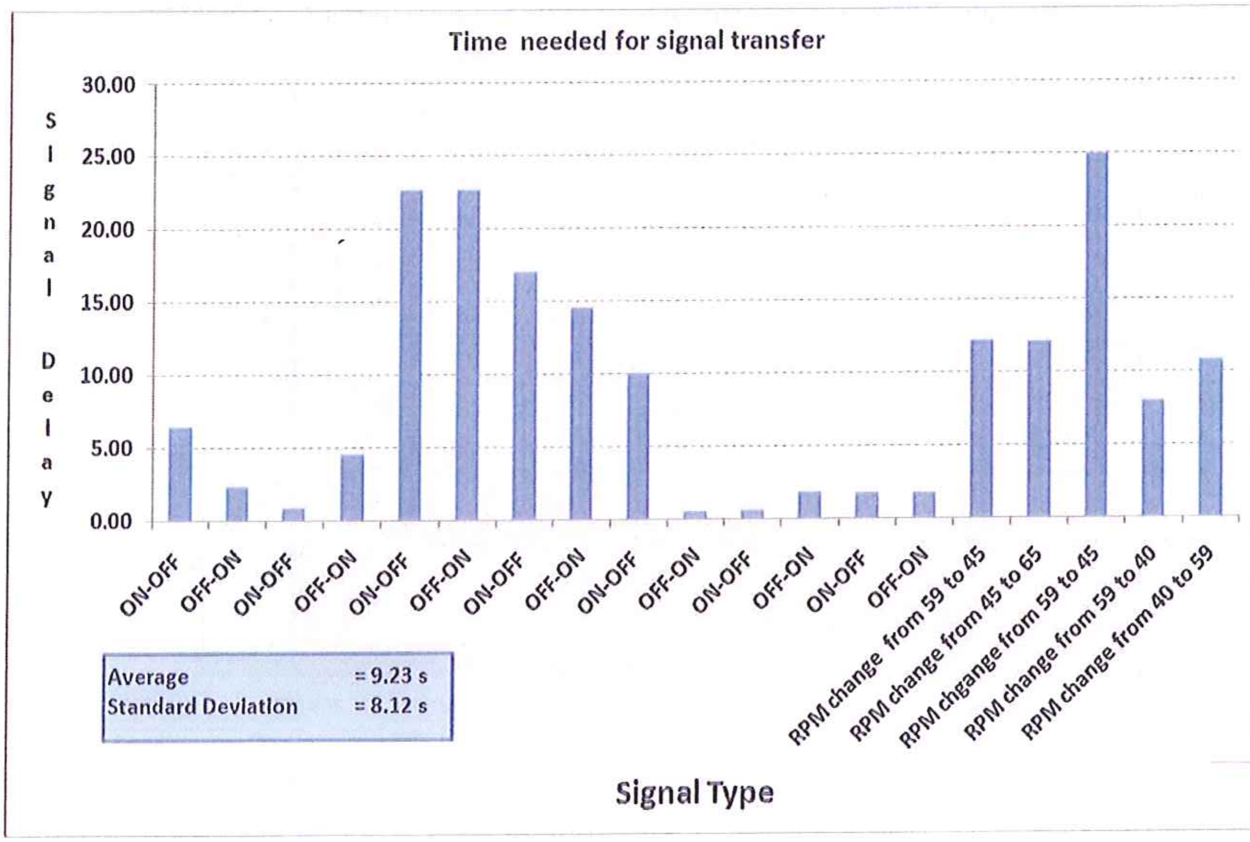
Annex 5

Table 2: Comparison of Parameters of well *29Ow05* with and Without Smart pumper

Date	FBHP	THP	Pannulus	Rpm	Bfpd	Bopd	Water cut	Remarks
Nov2010 to Mar 2011	170.90	81.67	30.83	123.88	10.63	9.45	10.47	None
Mar 2010 to July 2011	278.00	93.33	0.00	118.00	12.90	10.30	18.85	Smart Pumper Active
Diff (Sm P- No Sm P)	107.10	11.67	-30.83	-5.88	2.27	0.85	8.38	
% Diff icw No Sm P	*63%*	*14%*	*-100%*	*-5%*	*21%*	*9%*	*80%*	

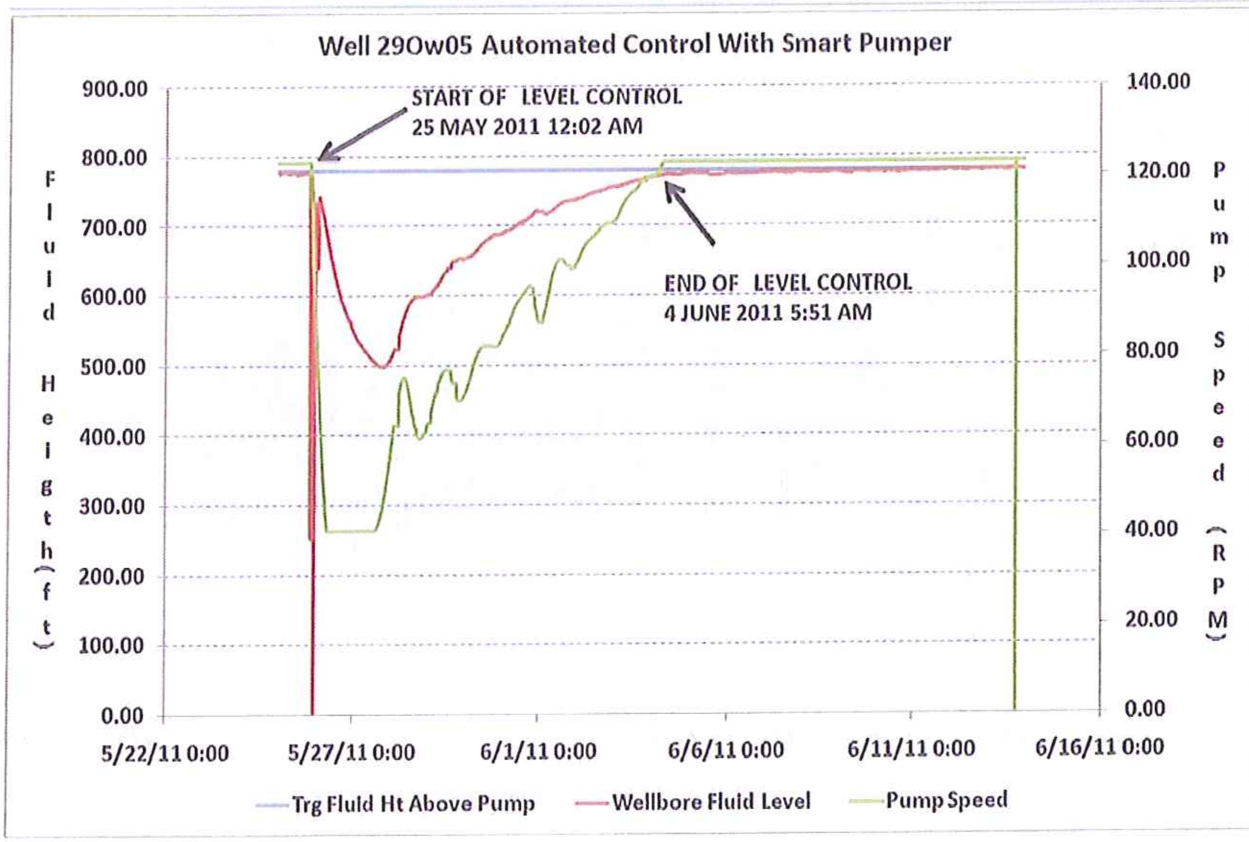
Annex 6

Graph 2: Signal Speed test of the smart pumper from internet desktop console to the smart pumper's controler in the Calcutta Swamp Operation



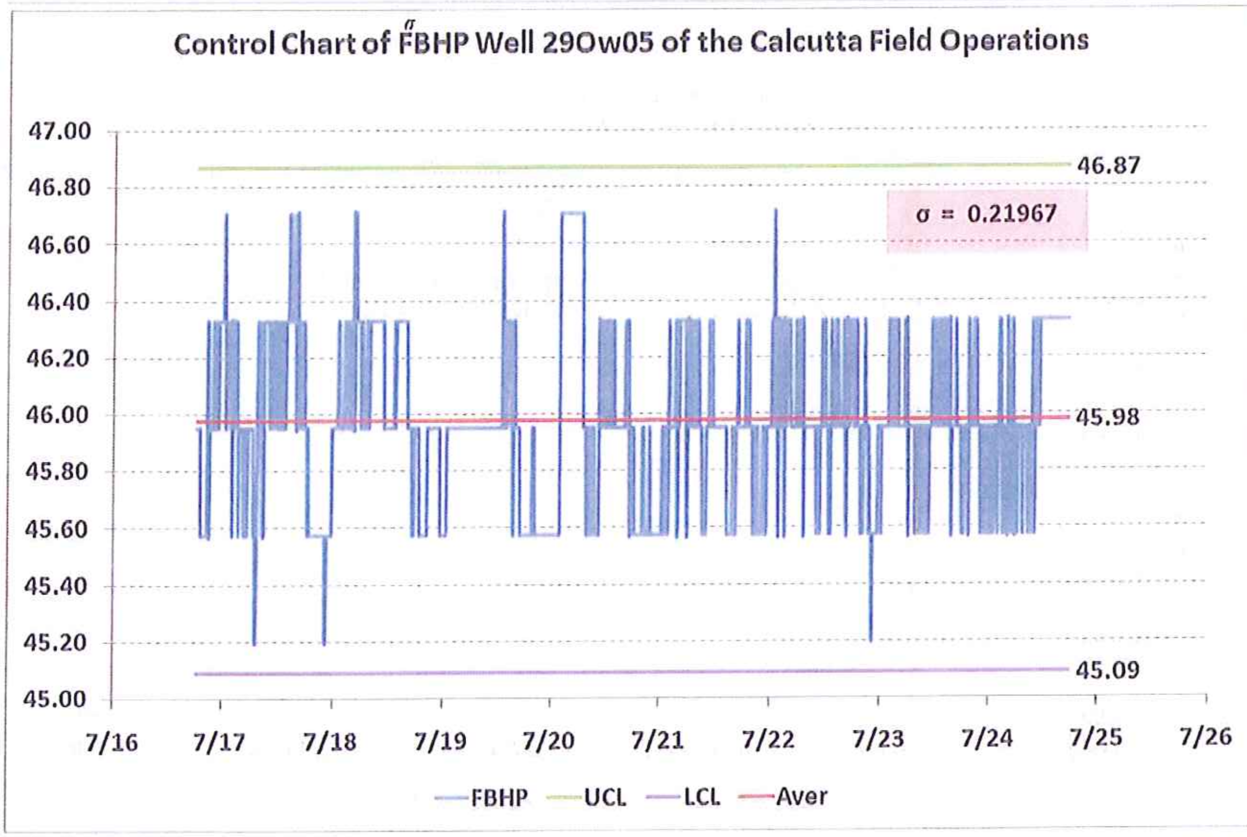
Annex 7

Graph 3: Automated Control of Fluid Level with the Smart Pumper



Annex 8

Graph 4 : Control Chart of FBHP Well 29Ow05 of the Calcutta Field Operations



SPE-157717-PP

Evaluation of a Smart Pumper System in the Saramacca Oil Fields-A Case Study

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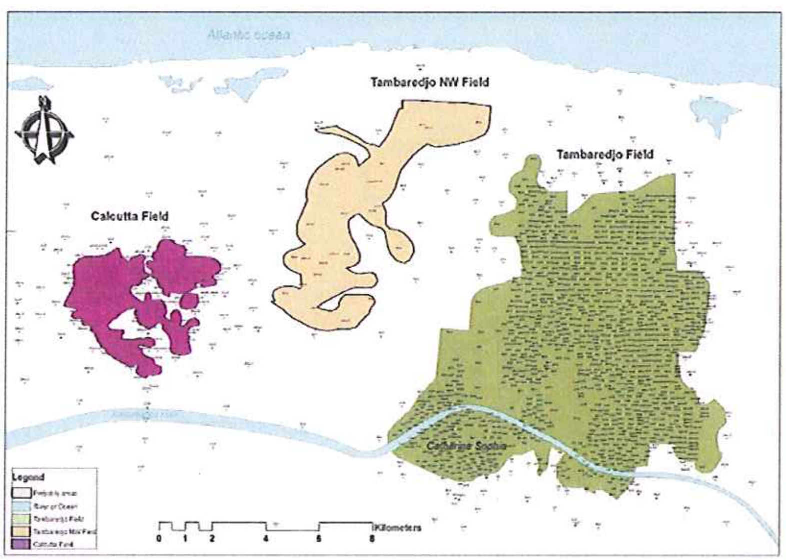
This paper was prepared for presentation at the SPETT 2012 Energy Conference and Exhibition held in Port of Spain, Trinidad, 11–13 June 2012.

Introduction

Currently, Staatsolie Maatschappij Suriname N.V. produces Saramacca Crude from the Tambaredjo, Calcutta and Tambaredjo North West Oilfields as illustrated in Fig.1. These oilfields are located in a marshy area in the coastal plain of Suriname, District of Saramacca, about 55 km west of Paramaribo, the capital of Suriname. By the end of 2011, daily production from both fields reached averagely 16,500 barrels oil per day from almost 1418 active producing wells in both dry and wetland. Crude oil of 15-17 o API gravity is lifted mainly by Progressive Cavity Pumps from the unconsolidated sand reservoirs, typically ranging from of 700-1100 ft depth.

Figure 1: Overview of the Saramacca Oil Fields in Suriname



Abstract

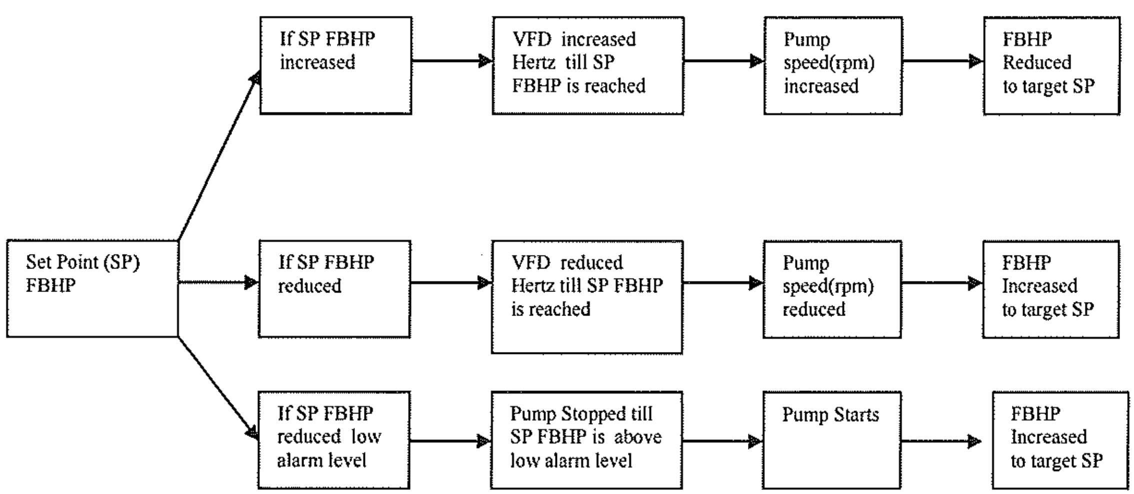
Well performance is monitored on a monthly base with the volume flow test and Flowing Bottom Hole Pressure (FBHP) measurements. In addition, down hole pressure data is also collected for build up tests and other reservoir studies. A very practical solution for this is to have a fully automated smart well system, which allows instant data access and also the ability to troubleshoot online real-time data.

Well operation

At the Saramacca Oil Fields the fluid level in the annulus is measured by Acoustic Well Sounder as well as Surface Read Out (SRO) Gauges on monthly base. Well production is measured according to its capacity on a monthly or bimonthly base. The purpose for measuring the level in the annulus space is to know the FBHP to determine if the well is being producing at its maximal potential and also to see if the fluid level in the annulus is still sufficient to prevent dry running of the Progressing Cavity Pump (PCP).
The smart well automatically regulates the artificial lift system by controlling the flowing bottom hole pressure in the annulus around a given set point and has a online diagnostic interface from where monitoring as well as control from each well can be done. It can also perform data logging at predetermined intervals and delivers key information needed for decision making. The built in software package automatically controls the well via a Variable Frequency Drive (VFD) on the well site location to a target SRO gauge pressure and can be changed from a remote location with a PC laptop at anytime. All the signals received from the smart well controller are sent via a wireless telephone signal and to an online server for storage. In the online interface there is also a possibility to set alarms and target values for fluid level in the annulus and it shuts the well in automatically when the FBHP is below the low alarm level. This system will automatically control the target fluid level in the annulus over time without any interaction in speeding up and/or slowing down when reservoir and or pump condition changes. Once the setpoints for FBHP are installed, the smart well automatically operates around these values even if the internet or phone connection is disrupted. Once the connection is restored the backlog of data is sent to the server for storage.

Having the smart well system in place will result in the following benefits:
1. A Variable Frequency Drive (VFD) controlled target Flowing Bottom Hole Pressure (FBHP)
2. Prevent the PCP pump from running dry
3. Online immediate detection of PCP failure detection

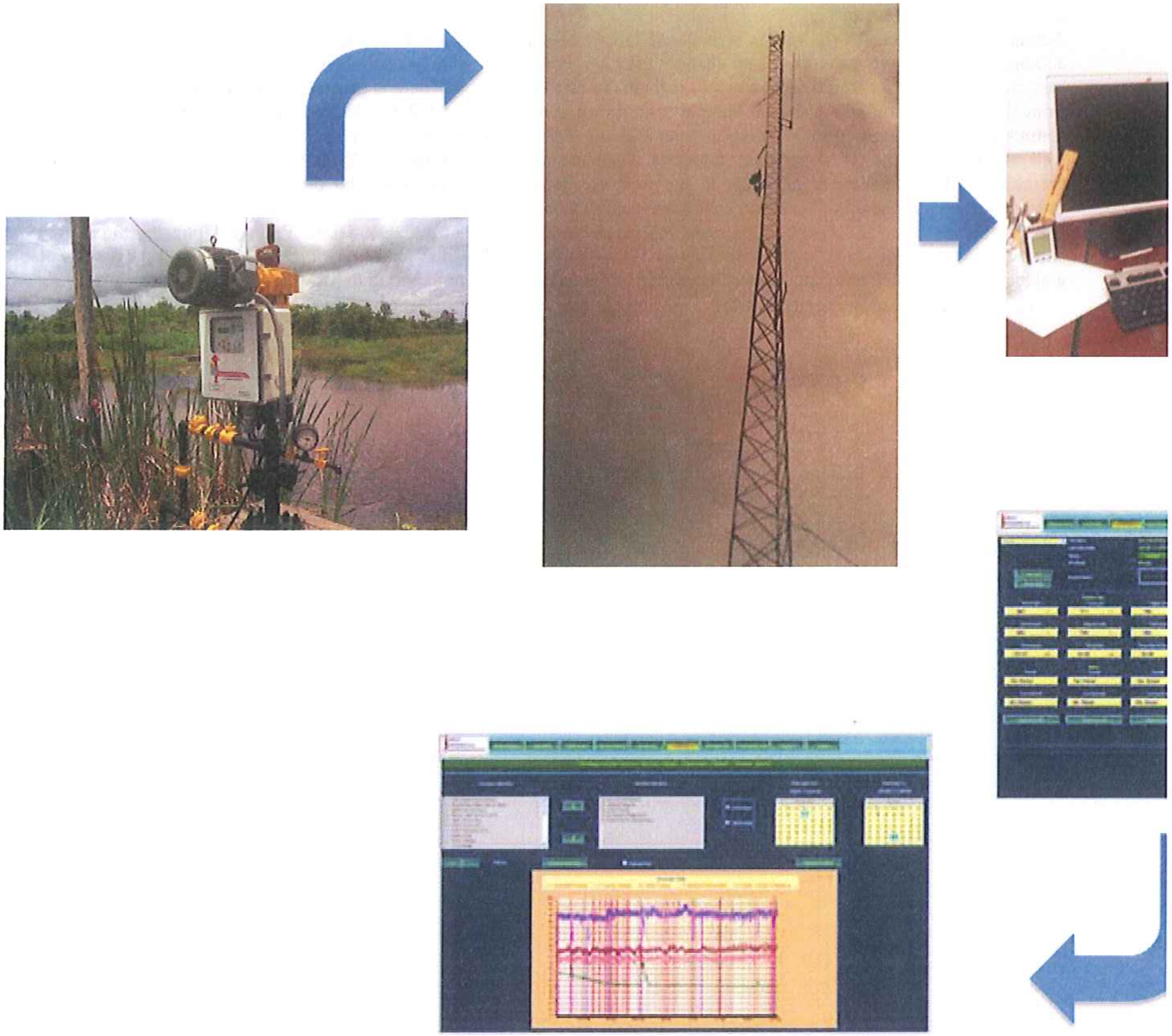
Picture 1: Control scheme of FBHP by smart well



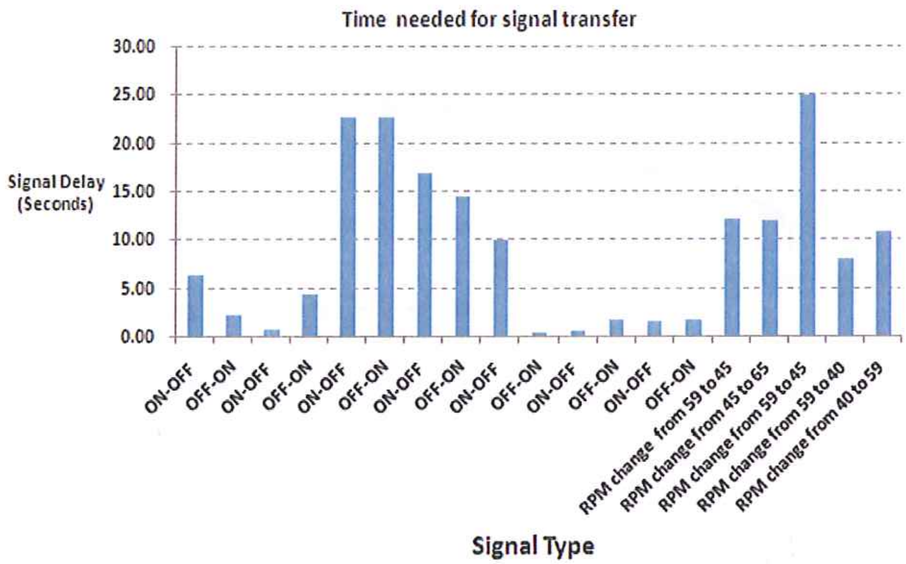
Smart well signal speed

Administrators' access to the online web based interface of the smart well system is user friendly and should only be for authorized personnel to make necessary changes after agreement with all the stakeholders of the respective wells asset owner. In case changes are made, then these are recorded in an On-line Log Report. There is generally a delay when executing a command from the user desktop to the Smart Pumper's hardware console in the Oil Fields from 0 to 39 seconds when sending the command from the desktop to the smart pumper and vice versa. Tests conducted by shutting the pump On and Off remotely as well as increasing the RPM show a variety of signal response. (See Graph 2) E-mail as well as automated SMS can be programmed in case there is an upset in the well as another means of close and direct communication. In Figure 2 the information flow is shown of the smart well automated system.

Data is captured from the downhole pressure and temperature, RPM, Torque, KW, Hertz, Voltage, Uptime% and Current Amp and sent via telephone signal to the online server. This data is then shown as a dashboard interface, with all the data available at a glance. With the available data present graphs or tables can be made or exported to MS Excel. Below a schematic is shown of the information flow of the captured data.



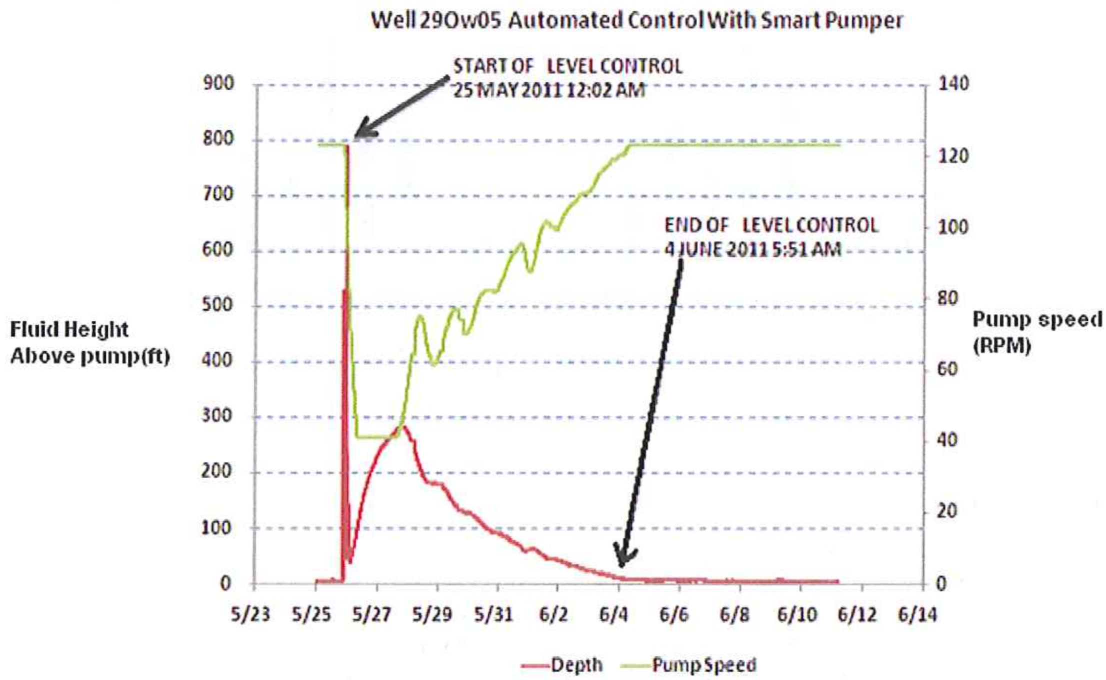
Graph 1: Signal Speed test of the smart pumper from internet desktop console to the smart pumper's controler in the Calcutta Swamp Operation



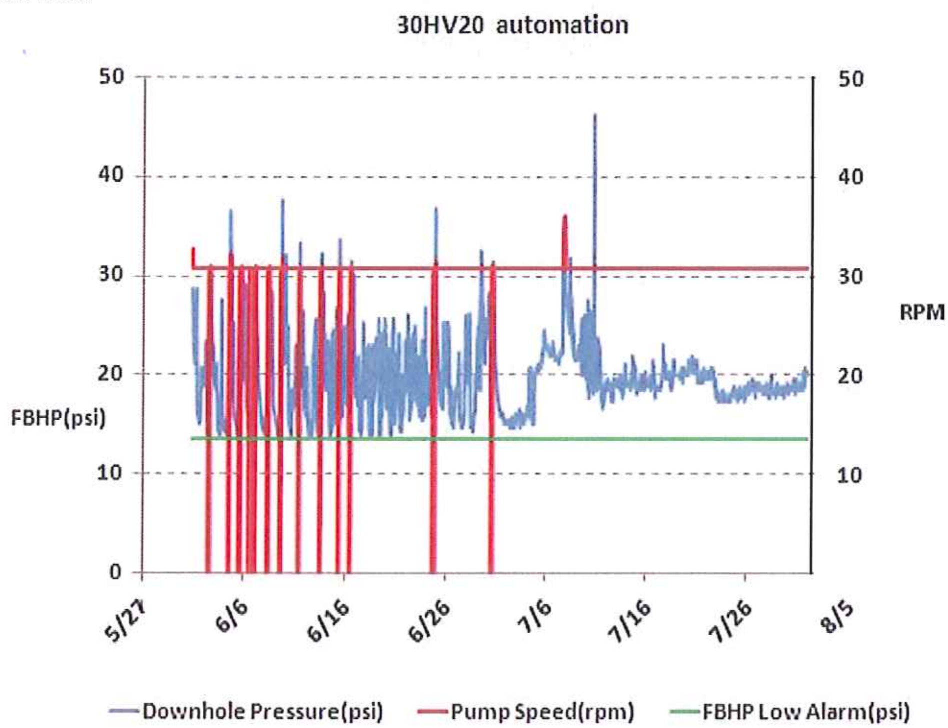
Results: Well Operation

a. With the smart well installed on well 30Nm02 there is a 12 BOPD increase in production due to the automated optimization of the smart well system (Table 1)
b. With the Smart Pumper installed on well 29Ow05 there is a 0.30 BOPD increase (Table 1) .Seems that this well has reached its maximum potential. The point from which there is a perturbation until this is corrected to the target level programmed in the smart pumper controller takes about 10 days (See graph 2).This programmed drawdown can be aborted at any time since all the FBHP info is online available. In this graph it is noticed that at 25 May 2011 12:02 am the fluid level in the annulus decreased smoothly from surface to target level of 780 ft was reached on 4 June 2011 5:51 am after it reached its target level. The automated system was installed on the new Well 30Hv20 and according to graph 3 has reached a plateau production and is producing steadily at an average production of 12.0 bopd. There can be observed that the smart well system automatically shuts off the motor of well 30HV02 when the measured pressure falls below the setpoint (SP) low alarm pressure of 13.5 psi and prevents the pump from running dry. The smart well installation will result in an early failure detection and take action according to the maintenance strategy of Staatsolie.

Graph 2: Automated Control of Fluid Level with the Smart Pumper system at well 29Ow05 at the Calcutta field operation



Graph 3: Automated Control of Fluid Level with the Smart Pumper system of Well 30Hv 20 of the Tambaredjo oil field



Graph 4: Well 30HV20 Oil production since startup

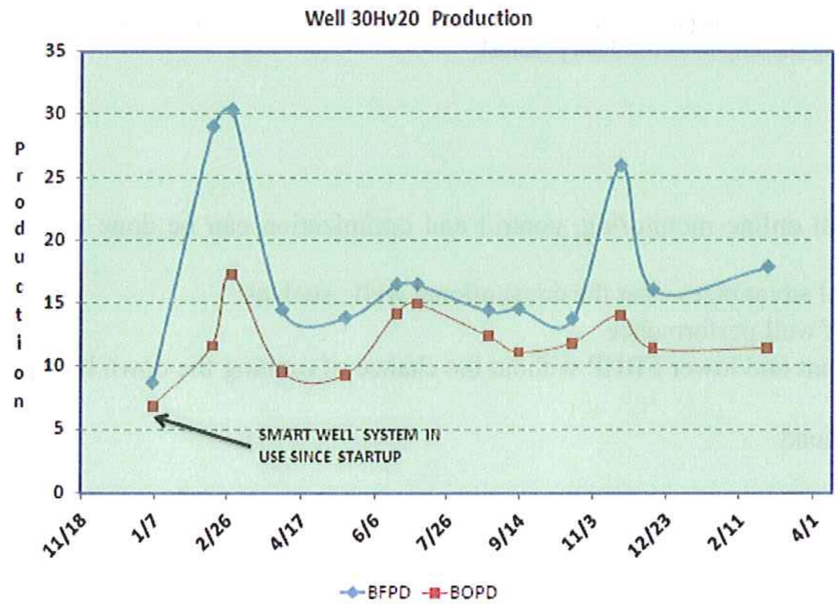


Table 1: Comparison of Parameters of well 29Ow05 with and without Smart pumper

BOPD				
Well	Before	After	% Diff	Diff bopd
30Nm02	29.8	42.1	41%	12.3
*30HV20		12.0		
29Ow05	8.9	9.2	4%	0.3
Total BOPD increase				12.6
BFPD				
Well	Before	After	% Diff	Diff
30Nm02	34.0	53.5	57%	19.5
30HV20		17.8		
29Ow05	9.8	11.5	18%	1.7
FBHP(psi)				
Well	Before	After	% Diff	Diff
30Nm02	286	94	-67%	-192
30HV20		239		
29Ow05	195	45	-77%	-150

*Note: For the new well 30HV20 the smart well system has been installed since taken into production

Benefits

There are several benefits of the smart well automated system which will compensate the higher installation cost. An evaluation of the economic benefits is ongoing. The advantages of the smart well system include: prevention of pump damage by running it dry, typically it takes 3 to 4 days to replace a downhole pump in the wetlands, reduced manpower associated with annular FBHP measurements and increasing the well lifting capacity to its maximal potential.

Conclusions

1. With the smart well system online monitoring, control and optimization can be done in remote areas.
2. The smart well offers several advantages over the conventional well , such as:
   - Online monitoring of well performance
   - Producing at a constant and lower FBHP without the chance of running the down hole pump dry
   - Reduced manpower load
   - Online PTA testing

Recommendation

1. To be able to have access to the online data for monitoring and adjusting the control settings it is recommended to have a high speed internet connection

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