2019 30th ESP Workshop

Summary of Presentations

Woodlands Waterway Marriott Hotel

Tuesday, May 14 – Thursday May 16, 2019

Prepared by
Cleon Dunham, Oilfield Automation Consulting, Artificial Lift R&D Council
May 25, 2019

Paper	Author(s)	Summary of Discussion
Purpose of this Document		
Purpose of this Document	**Cleon Dunham** **Oilfield Automation Consulting, Artificial Lift R&D Council**	The purpose of this document is to summarize the main points of the technical presentations at the **2019 ESP Workshop/Symposium**. If you wish to learn more, please review the actual papers. The papers can be downloaded from the ESP Symposium. If you didn't attend the Workshop, you can purchase a CD from the ESP Workshop Committee. These summaries are based on my **33** pages of notes. If anything is presented incorrectly, I may not have heard or recorded it correctly, so the fault is mine, not the authors and/or presenters of the papers. The lead authors (or the authors who presented the paper) are shown in bold color with each paper. The authors are welcome to correct the summaries if needed. • This is the **30th ESP Workshop**, now called the **ESP Symposium**. • The first one had **60** people. • Attendance at this year's workshop was **617** attendees in all, with **175** from Operating Companies. There were **36** Exhibitors and several Sponsors. **65** people attended Containing Education Courses. • Last time there were **561** attendees. • This year's attendees came from **35** separate countries. • They represented many different organizations. • Legend used for Q and A is: Q Question. A Answer C Comment

<table>
<tr><td></td><td></td><td>• I want to give a special thank you to Candice Torregano of GE Oil and Gas. She helped me a great deal in getting around the Workshop venue.</td></tr>
<tr><td colspan="3">Opening Comments
Workshop Co-Chair:
Leon Ben Waldner - Nexen Energy ULC</td></tr>
<tr><td>Opening Comments</td><td>Leon Ben Waldner
Nexen Energy ULC</td><td>A representative of the Mariotte Hotel gave a recorded Safety Briefing. This was repeated each day.

Leon Waldner, Chair of the 2019 ESP Workshop, welcomed the attendees.

Each technical session started with a quiz. People could “vote” their answer to the quiz by using an “application” on their phones. There were two questions each time. One was general interest and one had to do with an ESP topic. In general, most people got the answers mostly correct.</td></tr>
<tr><td colspan="3">Session I
High Speed Applications
Session Co-Chairs:
Diego Narvaez, Schlumberger
Mathew Hackworth, Oxy Oil and Gas Corporation

Can shorter and slimmer ESP Systems running at high speeds be more reliable? In this Session we will look at Case Studies of the development, testing, qualification and performance of high speed, high rate ESP’s.</td></tr>
<tr><td>Keynote Speech</td><td>Darcy W. Spady
Broadview Energy, 2018 ESP President</td><td>Making Global Innovation Work Across Boundaries
• State of the Industry
• Changes vs. Deniers
o Creative tension can be good.
o Hydrocarbons are important to the World’s economy.
o Echo chambers kill collaboration.
o There is too much of this in Calgary.
o Crews use energy – oil people are big users.
o Survey of Society of Petroleum Engineers (SPE)
o Survey of Professionals in Energy (Another SPE)
• Culture of Innovation
o Start everywhere.
o Flood energy groups.
o Interface fluidics.
• Finding Initiatives.
o Activity = innovation.
• Collaboration.
o We need a robust, global SPE.
o We need volunteerism.
o We need to focus on the SPE Sections.

Q. Who innovates?
A. North America.
Sucker Rod Companies.</td></tr>
</table>

		Midland, Texas Small Companies. Q. Who collaborates? What is open collaboration? A. Lawyers help. Can plan for collaboration.
SPE-194416-MS **World's First Mass Implementation of Ultra-High-Speed ESP Systems in Salym Group of Fields, Western Siberia, Russia**	**Anton Shakirov, Lex Submersible Pumps** **Y. Alexeev, Lex Submersible Pumps** **A Gorlov, Salym Petroleum Development, NV.**	**Salym Field**, Eastern Siberia, Russia This is about an ultra-high-speed ESPs used in the Salym Fields Siberia, in Russia. • Field started in 2014. • 90 wells on ESP. • High speed ESPs. High efficiency. • Permanent magnet motors. • Power savings of 20%. • Simple and quicker installation. • Run life statistics, up to 2 years + • Mean time between failures is increasing. • R&D – sand, high viscosity. • Power requirement is decreasing. Q. What do you mean by high speed? A. Some over 8,000 rpm. Size is decreasing. Now some over 11,000 rpm. Q. What is your typical depth and temperature? A. 4,000 meters. 110 c Q. How do you use your Permanent Magnet Motor? A. From 60 to 100 Hp. 1400 volts. Q. What is your GLR? A. Our GLR is not high. Q. How do you achieve high speed? A. We use a high-speed transformer. Q. How do you calculate run life? A. We use the Shell method. Q. Pot head? A. Use both methods. Q. Erosion? A. We have cable wear when run at 600 Hz.
SPE-194399-MS	**Rafael Lastra Melo, Saudi Aramco PE&D**	**Saudi Aramco** This is about use of high speed, slim hole ESPs in Saudi Aramco.

High Speed High Rate Slim ESP Development and Qualification Testing	**J. Xiau. Saudi Aramco, PE&D** **W. Lee, A. Radcliffe, Alkhorayef Petroleum**	Challenges: • They have casing corrosion. • They use 4.5-inch casing. • They produce up to 5,000 BPD. • Their pumps are short length. • They use a high-speed design. Operations: • They run up to 6,000 RPM. • They produce 5,000 BPD. • They use Induction Motors and Permanent Magnet Motors. • They have 4-pole motors. • They use 200 HP. • The motors are 30 feet long. • They can run at 3,000 – 7,500 RPM if needed. • They used inverted ESPs. • They use a high speed, high rate design. • They use tungsten carbide. Q. What is your standard pump? A. Normal and tungsten carbide. Q. What speed do you use? A. 6,000 RPM. Q. What is the GLR? A. It doesn't matter because we produce above the bubble point so there is no free gas. Q. Do you have corrosion? A. We have H_2S and CO_2 corrosion. Q. How do you protect your ESP? A. We use a hardened ESP. Q. What is your design frequency? A. 200 Hz. Q. Do you use coating? A. We use standard coating. Q. Do you have vibration problems? A. Vibration has not been a problem.

Session II
Through-Tubing Deployed ESP Systems
Session Co-Chairs:
Diego Narvaez, Schlumberger
Jeff Dwiggins, Artificial Lift Solutions Pte Ltd

This Session highlights the evaluation and implementation of Through-Tubing Deployed ESP Systems through innovative deployment techniques.

SPE-194390-MS **Accelerating the Shift to a Next-Generation ESP Deployment: Cable Deployed Through Tubing**	**Yip Pui Mun** **Petronas Caigali Sdn Bhd** Kautsar Zamanuri, N. Mohd. Radzuan, N. Salleh, E. Ouda, Petronas Caigali Sdn Bhd. E. Alexander, Consultant D. Bakhtuly, Novome	**Petronas Caigali** in Malaysia. Their first offshore, though tubing deployment of an ESP was in 2017. Advantages of this method: • No workover is needed to fix an ESP problem. • They are run in 2-7/8-inch to 4-1/2-inch tubing. • This was first tried onshore and then moved offshore. • This uses normal surface equipment. • They have been running for 2 years, with 80% uptime. • The production is assisted with gas lift. • They use a power cable. • There is 2 – 3 percent CO_2 and small amount of H_2S. • The wells produce with a high GOR. How candidates are screened: • Amount of gas production. • Tubing ID. • No sand. • Favorable economics. • They plan to use this on 6 wells in 2019 and 2020. Q. When you pull the ESP, is the cable twisted? A. No. Q. What is the depth? A. 1,800 feet.
SPE-194400-MS **Alternatively, Deployed Artificial Lift System for Deepwater Subsea Operations**	**Domitila de Pieri Pereira,** **Schlumberger** K. Scarsdale, M. G. Garber, K. H. Goh, B. Kee, n. Gastaud, Schlumberger, A Simon, Jeswin Joseph, Equinor W. Cook, Chevron Corporation	This is about using an ESP System in a deep water, subsea field. Advantages of using an ESP in this application. • ESPs produce these wells better than gas lift. • Workover costs are very high, so cable deployment saves on these costs. • There can be long delays in obtaining a workover rig. • For a workover, we have to plan long in advance. • Using cable deployment reduced rig time. • There are 10,00 feet deep wells. • With ESPs, we obtain a 20 – 30 percent production increase. • We needed to reduce the cost of ESP replacement. • We use inverted ESP systems. • We don't need to kill the well to install the ESP. • We can produce up to 11,000 BPD. • We use a 5.5-inch OD motor. • We use a 10,000-foot cable reel. • We use a rotary gooseneck. • We had to repair some damaged cables. Q. What were your cable problems?

		A. There were some pulling problems. Q. Do you need to use a gooseneck each time? A. Yes.
Session III **Power Supply, Quality** **Session Co-Chairs:** **Tom Van Akkeren, Production Technology Associates** **Brian Hicks, Hoss Pump Systems** Supplying good quality power to ESP's is critical to having extended pump run lives. Papers in this Session will provide information on how to evaluate power quality and ensure equipment will deliver it effectively.		
SPE-194411-MS **ESP Downhole Power Quality - Do we have a healthy cardiovascular system?**	**A.J. (Sandy) Williams, Artificial Lift Performance Limited** D. D. Shipp, Capstone Power Systems Engineering	This is about analyzing downhole power quality on ESP systems. Issues addressed. • Switchboards are larger to support VSDs. • There is a challenging operating environment for downhole power. • Flat cables are used. • There are high temperatures, changing GORs. • There are problems with poor power quality. • Some Operators don't do enough preventive maintenance; good preventive maintenance is needed. • Need to have good grounding to prevent lightning problems. • Harmonics can cause damage to the power system. • There can be common mode problems. • Bottom line: need good power quality. • Need to use a good transportation system to protect all components when being shipped to the well site. Q. Do you recommend use of power "chokes?" A. Can measure without shutting down the system. Q. What is the impact of a step-up transformer? A. Used to follow recommendations. Q. What are the concerns with system transportation? A. Need to provide good pump and system support during transporting the system to the location. Q. How can we prevent failures due to poor power quality? A. See these on the teardown and follow the recommendations.

SPE-194392-MS **Identifying and Preventing ESP Failures Resulting from Variable Speed Drive Induced Power Quality Issue**	**Milan Heninger, Enel Green Power** S. F. Grande, III, Magna Grande Distribution, Inc. D. D. Shipp, Capstone Power Systems Engineering	This is about preventing ESP Failures from poor Variable Speed Drive power. Issues addressed: • Most ESP Systems are not designed to deal with poor quality power. • They use inverters that run at 2,000 to 3,000 Hz. • They use Pulse Width Modulation (PWM) • VSD's convert AC to DC and back to AC power. • Work was done on Geothermal Wells that use ESPs. • Today there is no "Poor Quality Standard" for ESPs. • Other Industries to have such standards. • Common Mode Failures have increased to greater than 2 years. Q. Is it difficult to address problems with motors? A. It's because it is difficult to find the problems. Q. How can we improve motor quality? A. One way is to improve the bearings. Another is to improve the insulation. Use better wear factors. Q. Do you recommend high pulses? A. Use minimum load harmonics. Q. Have you tried Sine Wave Filters? A. We don't trust them. Q. How do you recognize failures? A. Look at the voltages used. Q. What types of filters are used? A. There are some improved Sine Wave Filters.

SPE-194402-MS **Design and Qualification Testing of ESP Cable to Improve ESP System Run Life**	**Dennis Harris, Chevron ETC.** R. Banman, Total E&P Canada, Ltd. D. Malone, Access ESP	This is about improving cable life to improve the run life of ESPs. Issues addressed. • Cables should last for a long time. • Cable failures are related to motor failures. • Most often, they fail due to poor handling. • There is a better way to overcome cable failures. o Use tubing-encapsulated cable (TEPC). o This is four times stronger than cable by itself. o It is better at high temperatures. o It reduced make-up time. o Cost is 1.3 to 1.4 more, but it is worth the extra cost. Q. Does this work with low temperatures? A. We didn't look at this issue. Q. Does this have an impact on discharge? A. This was not part of this study. Q. Can the tubing and cable be reused? A. This system is good for the life of the ESP. It can be reused. Q. Have you tested for failures at the connectors? A. It may fail at the end points.
Session IV **New ESP Technologies, I** **Session Co-Chairs:** **Tom Van Akkeren, Production Technology Associates** **Michael Romer, ExxonMobil** Technology to improve ESP Performance is continuing to be developed. These papers will discuss new ways to save costs and extend the operating envelope for ESP's.		
IP Using Variable Frequency Drive (VFD) for preheating the induction motor (IM) of Electric Submersible Pump	**Andrew Merlino, Shell**	This is about the use of ESPs in deep water. Issues addressed. • This is used in high viscous applications. • It is used at low frequency. • It uses a DC motor. • This was tested at Shell's Gasmer Facility in Houston, Texas. • Then it was tested at a Baker Hughes facility. • Then it was implemented Offshore in the Perdido Field. • All five systems are running with no failures. Q. Did you consider using low temperature oil? A. We looked at this. Q. Did you use a pre-heated procedure? A. We looked at for an extended time.

		Q. Did you test different ESP Suppliers? A. We used the same Supplier for all five wells. Q. Did you apply voltage to achieve the desired torque? A. We had 150 amps at 2,000 volts. Q. Did you measure the break-away torque on the tests? A. Yes, it was OK. Q. Was your target temperature or viscosity? A. Our standard temperature was 100 F.
SPE-194415-MS **Need a Lift? A Rotary Gear Pump, an ESP System without the ESP Pump**	**Dale Serafinchan, DASCO ESP Inc.** R. C. Chachula, Advancing Pump Technologies D. H. Dietz, Encana Corporation	This is about using a Positive Displacement (PD) pump with an ESP motor. Issues addressed. • Want to overcome ESP failures. • Want to have good drawdown. • Want to deal with heat in the motor due to low production rate. • Want to be able to handle solids. Characteristics. • This is a rotary gear pump. • It is a Positive Displacement pump. • The production rate is a function of the pump/motor speed. • It is a parallel rotary gear pump. • It has radial thrust vs. up thrust and down thrust. • The amount of pressure produced is related to the torque. • The pump is 5 feet long. • The pump was tested by CFER in Edmonton, Alberta, Canada. • It has a 4-inch drive. • It can produce up to 5,000 BPD. • It can handle gas. • It is highly efficient. • It uses a Permanent Magnet Motor (PMM). • It handles abrasions effectively – has a long life. • It can be installed in up to 9,000 well depths. • It uses lower power than an ESP. • It has been tested from low to high production rates. Q. Have there been flow problems? A. There haven't been any flow problems. Q. What sand did you use for the tests? A. We used regular sand. We tested with smaller sand. Q. How will it handle frac sand? A. The sand is pulverized into a paste.

		Q. How does it handle Gas? Is it vented out of the power stage? A. Gas is not vented. Q. It is serial, parallel, or a combination? A. It is both in combination. Q. How does it deal with heavy oil, high viscosity? A. It uses better seals, so it handles these very well.
Session V **Data Analytics, Surveillance** **Session Co-Chairs:** **Chris Scrupa, Compact Compression Inc.** **Song Shang, Schlumberger** A revolution (revelation?) in how field operating data is used to automate decision making and production optimization strategies is made possible by IoT, cloud computing, and inexpensive processing and storage capability. At the same time, the tried and true methods of fundamentally understanding and overcoming root causes of equipment failure must not be forgotten. Both new and traditional ways of analyzing data to improve processes come together in this Session.		

SPE-194414-MS
 	
Case Study Toward Digital Oil Field: How the ESP Operation Is Changing by Using "Automatic Well Models" In PDO's ESP Fields
	Atika Al Bimani, Petroleum Development Oman
	
	R. N. Kulkarni. C. Y. Lee, C. Giuliana, M. A. Al Musalami, A. Abdullah, K. Kamyani, Petroleum Development Oman
	
	M. Kumar, Weatherford International Ltd.
	
	R. D. Gala, Weatherford Houston
		This is about the Digital Oil Field used by **Petroleum Development Oman** (PDO).
		
		Issues addressed.
		• The system addresses ESP Design, Surveillance, and a Holistic Model of an ESP System.
		• PDO produces 70% of Oman's oil and 100% of its gas.
		• It uses 2,000 ESPs.
		• The ESP's feature downhole sensors.
		• The system features real-time modeling of the ESP system with updates every 5 minutes.
		• The system started being used in 2015.
		• All ESP design in done by using the system.
		• It is all done by local PDO staff.
		• Operation of the ESPs is based on the "Best Efficiency Point."
		• This saves $20,000 per well.
		• Well performance is monitored by PDO's Production Technologists (Production Engineers.)
		• Each person is responsible for 150 wells.
		  o They are responsible to maximize well run life.
		  o They eliminate up thrust and down thrust problems.
		  o They work with the Well Management System.
		• Well test validation is improved by using the system.
		• CAPEX is reduced.
		• They use "pattern recognition."
		• This provides large production gains and reduced production deferment.
		
		Way forward.

		• They will enhance automation and optimization. Q. How long did it take to get this system going? How did you get Management on board? A. We started working on this in 2007. It was first tried by Engineering across PDO. Q. Did you raise your ESPs to overcome deep submergence problems? A. This was to improve intake from the formations. Q. Did this improve your production? A. Yes, for us deeper is not good.
SPE-194401-MS **ESP Technology Improvements in Peregrino Field**	**Vinicius Yuri Ito Castro, Equinor** L. F. Pastre, Equinor J. Marins, Baker Hughes	This is about using ESPs in the offshore Peregrino Field in Brazil. Issues addressed. • Wells use open-hole gravel packs. • ESPs are installed beneath the production packer. • There is a tail pipe below the ESPs. • The field produces heavy oil, high temperature. • The pumps are set at 4,500 meters deep. • There are paraffin deposits in the seal sections. • There are power quality issues. • The temperatures and pressures oscillate. • We had motor rotor bearing failures. • We had mechanical failures. These led to loss of performance of the pumps. • There were asphaltene problems in the seals, in the top chambers. o We use two check valves. o We use a non-sticking coating. • We use a High Pressure, High Temperature (HPHT) packer penetrator. o It has a 10,000-psi rating. • We have 29 ESPs installed, with no failures. • We set a KPI on average run life and mean time to failure. • Our survivability is better than 75%. • We use two ESPs; they work together in tandem. Q. What is the depth of the packer? A. 2,300 to 4,000 meters. Q. What material are you using? A. Aflos. Q. How is this coordinated? A. With Equinor and Baker Hughes working together.
SPE-194384-MS	**Jianjun Zhu,**	This is about research done at the Univ. of Tulsa on ESP systems.

<table>
<tr><td>A New Mechanistic Model to Predict Boosting Pressure of Electrical Sub-mersible Pumps (ESPs) under High-viscosity Fluid Flow with Validations by Experimental Data</td><td>University of Tulsa

H. Zhu, G. Cao, J. Zhang, Uni-versity of Tulsa

H. Banjar, Saudi Aramco

H. Zhang, Uni-versity of Tulsa</td><td>Issues addressed.
• ESP performance curves are affected by viscosity.
• We studied the effects of the Euler Head Curve vs. the Red Head Curve.
• There were recalibration losses.
• There were friction and tensile losses.
• To address these issues, we developed a model.
  o First, we produced a flow chart.
  o Then we explored “closure” relationships.
  o Then we explored friction factors.
• We evaluated ESP geometry to validate our model.
• We developed a statistical definition of terms.
  o We compared these to catalog curves.

Q. What types of efficiency did you consider?
A. We compared our efficiencies with ones developed by others.

Q. How did you consider pump geometry?
A. We got this from the Manufacturers.

Q. Can others use the model?
A. Yes, for a price.

Q. Did you consider viscosity?
A. Yes, for this we needed to go to high resolution.</td></tr>
<tr><td colspan="3">Session VI
ESP High Temperatures
Session Co-Chairs:
Chris Scrupa, Compact Compression Inc.
Matthew Sikes, Oxy Permian EOR

Operators are demanding ever higher reliability from ESPS that often see bottom hole temperatures exceed-ing 250 C (482 F). The days of modifying conventional systems to function in this extreme environment are over. Though joint industry efforts, independent research, and empirical testing the specific challenges faced in high temperature environments are now being understood and game-changing technologies are being developed that are shaping the future of advanced ESPs.</td></tr>
<tr><td>SPE-194387-MS

Advancing High-Temperature ESP Technology for SAGD Applications</td><td>Jose Caridad, Schlumberger Reda

S. Shang, Schlumberger</td><td>This is a story about Steam Assisted Gravity Drainage (SAGD) in Northern Canada.

Issues addressed.
• Work was done to improve the reliability of the SAGD systems.
• This was based on good cooperation between Engi-neers, Operators, and Suppliers.
• Use high temperature ESPs.
• Inject steam to reduce the viscosity of the heavy oil.
• In 2003, we had the first break through.
• In 2011, some new technology was introduced.
• In 2014, we had the 3rd generation of the system.
• In 2016, this was upgraded to the 4th generation.</td></tr>
</table>

		• There were some material failures caused by high temperature.
		• 80% of the failures occurred in 20% of the cases.
		• Based on this experience, some design improvements were made.
		    o Better insolation provided a higher breakdown voltage.
		    o Better bearings, improved bearing wear with new materials.
		    o Better seals provide more stable operation.
		    o Better elastomers were achieved with better materials.
		    o Better motor oil provided better load carrying capacity.
		    o Other steps helped to move gas.
		• Reliability is improved in this 4th generation.
		• Failure analysis is proving to be very important.
		
		Q. What was the change from the 3rd to the 4th generation?
		    A. We addressed failure causes in the field.
		
		Q. What is the effect of high temperature?
		    A. This depends on how the Operation is pushed forward.

SPE-194420-MS
 	
Assessment of ESP No-Flow Events in SAGD Production Wells
	Shawn Prasad, C-FER Technologies	This is based on a study of SAGD conditions conducted by CFER in Edmonton, Alberta, Canada.
		
		Issues addressed.
		• No flow situations were being experienced in SAGD wells.
		• Some causes were considered.
		    o There is a drop in the gas production.
		    o The flow rate drops to 0.0.
		• What cause there no flow situations?
		    o Several sources were evaluated.
		    o Experience of others reported in ESP-RIFTS were evaluated.
		• We used flow models to evaluate the operation of the ESPs.
		    o The gas void fraction increased.
		• We looked at flow into the ESP intake.
		    o The temperature transfer was related to the area above the pump motor.
		• We looked at the ESP intake.
		    o The delta P was low.
		    o There was a difference if the pump was located in an up hole or a downhole direction.
		• There was no flow due to vapor in the pump.
		• This led to a Phase II redesign of the pump.
		
		Q. So, what are the causes of no flow?
		    A. Toe down installation is good. Gas is not entering the pump. Toe up leads to a high gas fraction.

Session VII **Reliability Analysis** **Session Co-Chairs:** **Cyril Girard, Artificial Lift Excellence AS** **John Graham, Suncor Energy Inc.** Reliability is a key part of our field economy and profitability. The papers to be presented in this Session are addressing, in their own ways, the understanding of reliability, how to use reliability on field economy and how we improve reliability by engineering.		
SPE-194398-MS **Reality vs. Expectations for Reliability Analysis**	**M.A. Dowling**, Perenco LLC	This is about of a study of Reality vs. Expectations for Reliability Analysis conducted by Perenco. Issues addressed. • 4,513 ESPs have been installed. • This is in 890 wells. • A survivability analysis was conducted. • 90% of the ESPs survived. • 30% survived less than 6 months. • 10% survived less than 30 days. • ESP reliability increases with increased run life. • Some Operators have a philosophy of "let the ESP keep running." • Don't be afraid of used equipment. • It may be part of an earlier problem. Q. So, what if ESPs fail in less than six months? A. If its not working, "blow" it up, or use gas lift. Q. Define problem wells. A. Yes, this is a good idea.
SPE-194393-MS **Interpretation of ESP Reliability using Weibull and Dynamic Run Life Analysis**	**Abdulla Al-Jazzaf, Kuwait Oil Company** A Pandit, N. Al Maqsseed, Kuwait Oil Company	This is about the experience with ESPs in Kuwait. Issues addressed. • There are 1,900 ESPs. • 1,600 of them are operational. • Sensors are used on all ESPs. • And there is surface data collection. • All pumps are leased • We conducted a Weibull Analysis. • This looks at how to use data to improve performance. • An important process is "benchmarking." • Areas of importance were identified. • How the Weibull Analysis is used. o It is used to improve performance. o It is used to understand causes of poor run life. o Evaluate failure risk factors. o Understand the likelihood of failure to know which wells to address. o Reduce the number of shutdowns. Q. What are the factors that cause failures?

		A. All ESP equipment fails at one time or another. Q. What do you differently for your poor wells? A. We try to manage the shutdowns. Q. What is the best approach for the better wells? A. We have the best people work on the better wells. Q. Do you evaluate the root cause of failures? A. Yes, we take care to do this.
SPE-194406-MS **Very Low Frequency Acceptance Testing for an Electric Submersible Pump Cable**	**David Beck, Haliburton** T. Glasscock, Haliburton D. Bollinger, HV Technologies	This is about testing ESP cables in the Permian oil fields. Issues addressed. • We apply tests at different levels. • We've conducted a 2-year study in the Permian Basin. • We looked at 551 test samples. • We used the Tar-Delta Method. o We detected large faults. o We used a method by the Power Industry. • We studied Tar-Delta variability. o This is a better method. • We studied Tar-Delta Tip Up. • We looked at the Tar-Delta Skirt. o This didn't add any value. • The Koreans developed a method to evaluate run life with good accuracy. o It is flexible and gives good diagnostics. Q. Do you section the cable? A. We conduct an acceptance test of the cable. It is used on new cable. Q. How do you handle different cable lengths? A. We test different lengths. Q. How do you handle "false negatives? A. We use the Korean method to decide if it is OK. Q. How do you handle higher voltages? A. We use the real voltage range. Q. Do you do your measurements in the field? A. Yes. We have to shut down the ESPs to perform the measurements.
Session VIII **New ESP Technologies II** **Session Co-Chairs:** **Cyril Girard, Artificial Lift Excellence AS** **Mark Cowie, Equinor ASA**		

<table>
<tr><td colspan="3">R&D initiatives, projects, and products that address very specific applications or challenges have the ability to create a technological step change for ESPs and drastically affect operator field economics. Papers in this section will look at some these new “out of the box” ESP technologies.</td></tr>
<tr>
<td>SPE-194404-MS

ESP Protector Mechanical Seal Run-life Extender</td>
<td>Dr. Hassan Mansir, COREteq Systems Limited

A Bencze, COREteq Systems Limited

L. B. Waldner, CNOOC International

J.K. Graham, Suncor Energy Inc.

C. Hong, Cenovus Energy

B. Duong, Alberta Innovates</td>
<td>This a story about mechanical seal reliability.

Issues addressed.

Seal sections are critical to the life of the ESP.
They are used to stop solids from damaging the steel.
25% of all failure occur in the seal section
54% of “tested” failure occur in this area.
The “Seal Run-Life Extender” is between the seal section and the pump intake.
It is a two-stage device.
It spits out particles.
So, the remaining fluid is clear.
We built a ½-scale model for testing.
Then we built a full-scale model, designed for use in SAGD.
Test conditions:
400 – 500-micron glass solids.
Optimization on a small scale.
The full-scale model used lessons learned with the test model.
We conducted a “thermal soak” test.
We tested it in water.
We tested it at 6,000 BPD.
We then tested it in a test well.
It has now been running in Canada for 2 months.

Q. How was the delta P on the seal section?
A. It was OK.

Q. You ran it in steady state. How did it shut down?
A. We designed it to run. Not like the Reda design.

Q. Do you plan cycle testing?
A. We will answer this later.</td>
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<tr>
<td>SPE-194391-MS

High Reliability Protector-less Artificial Lift Technology for Electrical Submersible Pumps/Compressors</td>
<td>Kuo-Chiang (K-C) Chen, Upwing Energy

P. McMullen, B. Biddick, L. Nadar, C. Sellers, Upwing Energy</td>
<td>This is about a high reliability protector-less system for ESPs.

Issues addressed.

The product does a good job.
Need a protector-less test to reduce losses.
This is used to increase gas production.
Uses a Permanent Magnet motor.
This runs at 50,000 RPM.
It has an isolated seal section.
The system is fully sealed to protect it.
A magnetic radial bearing supports the radial forces.
The bearing controls the pressure on the rotor disk.
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		Q. Does it handle gas? A. This is no problem. Q. Does it combine with the bearings? A. Yes. Q. What is the lubricant? Is it oil? A. We use gas. Q. Do you use it with sensors? A. It is sensor-less. Q. How much is the heat loss? A. We don't have any heat loss. Q. How high is the temperature? A. 380 Degrees C.
Session IX **Dealing with Unusual Operational Requirements** **Session Co-Chairs:** **Francisco Alhanati, C-FER Technologies** **Ceyda Kora Gursel, Chevron** Unusual operational requirements create the need for novel design workflows. In this Session we will see how Operators have accommodated such unusual requirements, in a variety of applications.		
SPE-194408-MS **Electrical Submersible Pump Powered Injection (ESPPI) Systems Enables the Development of West of the Nile Egypt Assets**	**Mohamed AbouTaleb.** **Qarun Petroleum Company** M. Munoz, Apache Egypt J.L. Dwiggins, Artificial Lift Solutions Pte, Ltd	This is about use of ESPs in Egypt. Issues addressed. • There is a JP between Egypt and Apache. • They produce 14% of the oil in Egypt. • They operate 600+ wells. • ESPs are used on 75% of them. • The field is 160 km. from Cairo. It is in an agricultural area. • This is a water flood. The water zone is above the oil production zone. • It is an ESP powered injection system. • Since the water source is downhole, there is a small footprint on the surface. • The zone has less than 10 m.d. permeability. • The wells use 9 & 5/8-inch casing. • They use a high rating on the ESPs. • There is a CAPEX savings since the injection source is down hole. • There is also an OPEX savings. • They plan to use VSDs in the future. • They get greater than 800 days run life. Q. Do you ever bring water to the surface? A. No, it is all downhole. Q. Did injection ever run out?

		A. This depends on which time you're thinking about. Q. Do your tools ever wash out? A. No. Q. Does the salinity cause erosion of the Y tool? A. There is no erosion. There is some corrosion. Q. How do you measure the injection? A. We use spinner surveys. Q. How often do you measure the injection? A. Once per month. Q. Do you experience cross flooding? A. No, the system is equalized.
SPE-194417-MS **Use of New Design Tool Improves ESP Design Across the Life of Well in Unconventional Applications**	**A.J. (Sandy) Williams, Artificail Lift Performance Ltd.**	This is about an uncommon application to improve ESP design and run life. Issues addressed. • This decreases the flow rate. • It helps change the water cut. • It increases the GOR. • The reservoir pressure is reduced. • It handles solids. • There are 800 ESPs run in the Permian Basin every year. • This is an ESP sizing tool. • We do this by using Type curves. • The software model we use in very good. • It can qualify choke design. • It is designed for the life of the well. Q. How does it work with Pressure and Temperature? A. The software does uses a stage by stage envelope. Q. Is it under loaded at full speed? A. It reduced friction. Q. Is the application standalone? A. It is not standalone. Q. Is it easy to use? A. Engineering support is needed to use it. Q. Is it a single stage? A. Yes. Q. What downhole pressure model do you use? A. Hagedorn and Brown.

SPE-194403-MS **Analyzing SAGD Producer Flow Instability and ESP Deterioration Using Dynamic Flow Simulations: A Field Case Study**	**Song Shang, Schlumberger** C. Nascimento, N. Bustamente, Schlumberger Canada J. K. Graham, T. Babatunde, Suncor Energy Inc.	This about instability in SAGD production flow. Issues addressed. • The wells produce with a low GOR. • The viscosity is low. • We are seeking stability in the ESP performance. • There are wellbore effects that need to be considered. • We use a Black Oil model. • There is water vaporization. • For this, we use a composite model. • This combines with a Hydraulic model. • We seek to obtain model validation. o We run a step-by-step test. o We run a transient test. o We measure temperature during a fall-off test. o We measure the pressure and temperature profiles to match the model. o We see large temperature variations. Q. How do you consider gas flow? A. We use gas void fraction. Q. How do you obtain flow data. A. It is a complex model.
Session X **High GOR Applications** **Session Co-Chairs:** **Francisco Alhanati, C-FER Technologies** **Marisela Rojas, Shell** High GORs are a known challenge in unconventional applications. In this Session we will review interesting solutions implemented by Operators and the results achieved in terms of higher drawdowns, more stable operations, and reduced failure rates.		
SPE-194396-MS **Downhole Gas Separation in High GLR ESP Applications**	**William Tyler, Oxy** Matthew Sikes, Occidental Petroleum Reda El Mahbes, Baker Hughes B. L. Nicholson, C. Yicon,Oxy Inc.	This is about a High GOR application. Issued addressed. • The field produces CO_2. • The reservoir pressure is 300 – 400 psi. • We have problems with gas locking and overheating. • Fluid enters at the top of the system. • The gas escapes up. • The ESP is shrouded. • There are frequent shutdowns. • The GOR is less than 2,000. • The system handles the CO_2. • It is a custom operation. Q. What is the ESP depth, the top of the shroud? A. Didn't hear the answer Q. Is this an inverted shroud? A. Gas separates in the shroud.

		Q. Is the downward velocity less than 0.5 feet per second? A. It stalls at the top of the shroud and this is good. Q. How many systems are installed? A. Over 60 are installed. Q. How many have failed? A. Two have failed.
SPE-194418-MS **Improving Gas Separation in ESP for Unconventional Wells in 5-1/2" Casing. (Case Studies in the Permian Basin)**	**Gustavo Gonzalez, Odessa Separator Inc.** C. Loaiza, Chevon	This is about gas septation in the Permian Basin. Issues addressed. • We have gas "slogs." • We get better shutdown performance. Q. Is this low cut, heavy oil? A. This was looked at in Colombia. Q. Is this run at the same speed as in Colombia, or a different speed? A. Same speed. Q. Is the liquid rate based on horsepower? A. We use a Helix to help model the flow rate. Q. Do you use a gas shroud? A. Yes, the shroud handles the gas. Q. Do you have oscillations in frequency? A. The VFD handles this.
SPE-194396-MS **Downhole Gas Separation in High GLR ESP Applications**	**William Tyler, Oxy** Matthew Sikes, Occidental Petroleum Reda El Mahbes, Baker Hughes B. L. Nicholson, C. Yicon,Oxy Inc.	This is about the Atlantic Field in Brazil. Issues addressed. • We have unconsolidated sand. • We use an open-hole gravel pack. • We produce heavy oil. • The ESPs are 1,500 to 1,600 meters deep. • The wells are horizontals. • The ESPs run at 1,600 HP. • 3 wells have been drilled. • We use screens with two layers of filtration. • We get a 5,000-psi pressure drop. • There are mobile fines. • We have a gas lift valve to inject diesel. • We use two motors, each are 800 HP. • The oil is 1,000,000 cp. • The design production rate is 2,300 BPD. • We use an FPSO to support the system. • We start the ESPs at 40 Hz. • Then we ramp up to 62 Hz. • We have had no damage on start-up.

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<td>Q. Why do you start at 40 Hz?
A. This is the recommended starting point. Below 40 Hz it doesn’t work.

Q. Why doesn’t the gas lift work?
A. It cools the oil and increases the viscosity.

Q. Why do you go up to 62 Hz?
A. We can archive the 800 HP at 62 Hz.

Q. Why do you use a low ramp up rate?
A. We do this to limit the draw down.

Q. What is your productivity index?
A. We have a high PI for the heavy oi.</td>
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<td colspan="3">Session XII
Alternative ESP Deployment
Session Co-Chairs:
Robert Rivera, Kinetic Pump Innovations
Matthew Sikes, Oxy Permian EOR

So long as ESP reliability is less than the life of the well, alternative, non-conventional deployment methods for ESPs will forever by a topic of interest for our industry. This Session focuses on the very nature of what it means to reel these systems in and out like a pro fisherman trolling for trout. If you’ve ever been interested in how alternative deployment has been tried in the high stake onshore and offshore arena, you need to attend this Session because we have all of this and probably more.</td>
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<td>SPE-194419-MS

20 Years of Rigless ESPs in Alaska; What went Right, what went Wrong, What’s Next?</td>
<td>John Patterson
Patterson Consulting

G. Dorman, M.D. Jensen, ConocoPhillips Alaska, Inc.

G. Targac, Conoco, Phillips

D. Malone, S. A. Cheblak, M. Walker, Access-ESP

J.Y. Julian, BP Exploration</td>
<td>This is about use of Rigless ESPs in Alaska.

Issues addresses.
• Oil gravity is 16 – 20 degrees API.
• The pump is a Progressing Cavity Pump installed through tubing and driven by an ESP motor.
• The first installation was in 1998.
• Dog leg severity was 4 – 12 degrees.
• The well had a 20 - 80-degree inclination.
• The system ran for 5+ years.
• The PCP had a 12 – 18 month run life.
• There were coupling problems.
• The system went right, then it went wrong.
• Results:
o The system reduced OPEX.
o There was no flexibility.
o Over 300 were installed in Alaska.

Q. Why didn’t you use ESPs?
A. Because of the dog leg severity.

Q. Did you have problems with twisted cable?
A. This depended on the type of cable. Board was bad.

Q. Why did you choose a PCP?</td>
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<tr><td></td><td></td><td>A. We needed a slow speed pump to use with the Permanent Magnet Motor.

Q. Did you have issues with the packer?
A. We had trouble unseating the packer.

Q. Did you measure the performance downhole?
A. We used downhole measurements.

Q. How did this work out?
A. The systems ran for long duration.</td></tr>
<tr><td>SPE-194412-MS

Alternative ESP Deployment in Offshore Field, West Africa</td><td>Jack English, Chevron Retired

S. J. Vierkhandt, L. Olabinjo, Chevron

D. Malone, AccessES</td><td>This is about ESP experience on offshore Angola, in West Africa.

Issues addressed.
• This was a natural water flood.
• We first used gas lift.
• Now we have 28 wells, on three platforms.
• All use ESPs.
• We use 2” coiled tubing to install the cables.
• We obtained good run life.
• Five years MBF.
• Needed to make a change due to high workover costs.
• We considered two techniques.
o Run an ESP with a Permanent Magnet Motor.
o Run it with an Induction Motor.
• We chose Option #1.
• We got poor results; only minor improvements.
• In 2015 we installed the first ESPs.
• In 2017 we installed the first Option #1 system.

Q. In 7 – 8 months you had the first change out. Why?
A. We were not prepared for the first failure.

Q. What caused the first failure?
A. Short run time.</td></tr>
<tr><td colspan="3">Session XI
ESP Sub Sea
Session Co-Chairs:
Robert Rivera, Kinetic Pump Innovations
Arthur Watson, Schlumberger

Subsea ESP Systems are challenging at best and considered all but impossible at worst. However, they have found a place in the Artificial Lift world, and not surprisingly, have proven to be both viable and profitable. This Session provides some of the latest information on how a relatively new development on an in-well, ultra-high horsepower system has found its way into a very challenging application, and a more mature mudline concept has been improved to bring value to the Producer’s bottom line.</td></tr>
<tr><td>SPE-194407-MS</td><td>Carlos Pedroso, Quei-</td><td>This is about a very powerful ESP installed in deep water offshore in the Campos Basin in Brazil.</td></tr>
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Starting Up the Most Powerful ESP Installed into Deep-water Offshore Wells Completed with Open Hole Gravel Packing: A Real Challenge.	**roz Galvao Exploration Production SA** B.F. Cavalcante, M. D. Marsili, M.P. Santos, Queiroz Galvao Exploration Production SA	Issues addressed. • Production is 35,000 BPD. • It is heavy oil. • Over 90% water cut. • The water depth is 1,000 to 1,500 meters. • The ESP is installed on the seabed, not down in the well. • Four ESPs are installed in one area. • They are 1,500 HP. The drives have two motors. • They can produce the wells with gas lift if an ESP fails and is not available. • The oil is 100 cp viscosity. • Gas locking is a problem with the ESPs. • They are working to obtain good ESP run time. • They have evaluated the failure modes. o There have been some protector failures. o Pump failures are rare. o There have been no inlet failures. o There have been no premature failures. o Failure are not related to the number of starts. • The ESPs are running longer. Q. What is the impact of start/stop? A. There has been no impact of this.
SPE-194385-MS **Successful First ESP Project Offshore Brunei – Building ESP Capability**	**Y. Yasmin, Brunei Shell Petroleum Sdn Bhd**	This is about the first successful offshore ESP project in Brunei Shell Petroleum. Issues addressed. • They use a team whose members are dedicated to the ESP usage. • They calibrate the team with special training. • They have meetings to discuss and make pre-startup decisions. • They hold workshops to review issues. • There is an ESP Vendor located offshore. • There is dedicated coaching for Operators. • Results: o Fifteen subsea ESP systems have been successfully started. o There is good feedback from the team. Q. What is remote control? A. We change operating parameters offshore. We perform automatic checks from offshore. Q. How do you keep specialists working on ESPs? A. We have a succession plan.
Session III Symposium Wrap-Up		
Symposium Wrap-Up		**Brief summaries were presented for the four Breakout Sessions.**

	Breakout Session Summaries	**1. ESP Standards – What's Next?** • Input to the Standards is needed by all Operating Companies. **2. ESP Transportation** • There needs to be good, safe shipping methods. • Operating Companies need to have good operating practices. **3. ESP Efficiency Management** • KPI's are needed for Power Consumption **4. Young Professionals – Make ESP's your Specialty** • This can provide Job Security, Long Careers.
	Symposium Summary by Lisette Barrios **Shell Oil Company**	**A brief summary of the 2019 ESP Symposium was provided by Lisette Barrios.** **Lisette Barrios** was the **Vice Chair** of this year's Symposium. She will be the **Chair** of the next **ESP Symposium** in **2021**. She reiterated the statistics of this year's event. • There were 617 Attendees. • Of these, 175 were from Operating Companies. • They came from 35 different countries. • 31% of all attendees were Internationals. • There were 36 Exhibits. • 65 people attend Continuing Education Courses on Monday. She thanked all attendees.