12º CONGRESSO BRASILEIRO DE PESQUISA E DESENVOLVIMENTO EM PETRÓLEO E GÁS

TÍTULO DO TRABALHO:

REVIEW ON RISERLESS LIGHT WELL INTERVENTION TECHNOLOGY AND RESEARCH

AUTORES:

Gabriel Aelo Ribeiro[1], Adriel da Anunciação Santana[1], Petrucio Leal Pereira[1], Saulo Queiroz Figliuolo[1], Valter Estevão Beal[1], Hugo Francisco Lisboa Santos[2]

INSTITUIÇÃO:

[1]Desenvolvimento de Produtos Industriais, Centro Universitário SENAI CIMATEC.
[2]Centro de Pesquisas, Desenvolvimento e Inovação Leopoldo Américo Miguez de Mello - CENPES/PETROBRAS.

REVIEW ON RISERLESS LIGHT WELL INTERVENTION TECHNOLOGY AND RESEARCH

Abstract

Procedures and operational tools for the intervention of subsea wells are challenging for Oil & Gas Industry and it demands research, innovation, and development to reduce costs and increase safety. While platform wells are intervened 2 to 4 times a year, subsea wells are only intervened if it is necessary. These interventions only occur when the well barrier has collapsed, or the production has substantially lowered because of the cost and difficulty associated with the assessment of these structures. This insufficient intervention frequency can lead to an estimated reduction of around 20% of the hydrocarbon recovery rates in subsea wells. Commonly, this type of work has been done by semi-submersible drilling rigs, which is not the best cost-benefit strategy for that end due the need to connect intervention rigs to the subsea trees through expensive equipment. Another approach that has been implemented in recent years is the use of Riserless Light Well Intervention (RLWI) techniques, which has represented a saving up around 50 – 40% on the intervention costs for oil companies in the last years. This work aims to make a review of RLWI technique and current advances in research on this subject. For this overview, a bibliometric initial search was made to understand the metrics and actual number of scientific works and patents about this subject, and the most relevant ones were discussed in this work. A table summarizing the works discussed was generated at the end of the paper, where its main characteristics are shown.

Keywords: Subsea wells, hydrocarbon recovery rates, semi-submersible drilling rigs, Riserless Light Well Intervention.

Introduction

The intervention of subsea wells presents significant challenges for the Oil & Gas industry, requiring research, innovation, and development to enhance safety and reduce costs. Unlike platform wells, which undergo interventions two to four times a year, subsea wells are only intervened when necessary, which typically occurs when a well barrier has collapsed or when there is a substantial decline in production (Håheim et al., 2003). This low frequency of interventions can result in an estimated reduction of around 20% in the hydrocarbon recovery rates from subsea wells (Arvind Keprate & Mohammed Ali Mohammed, 2016).

Traditionally, subsea well interventions have been performed using semi-submersible drilling rigs and running a workover riser system (Rosetto et al., 2001). However, this method is not the most cost-effective approach, because the use of semi-submersible rigs requires the connection of intervention rigs to the subsea trees through expensive equipment, adding more to the overall operational complexity and cost, which is in the order of 10 times higher than comparable platform/”dry” well operations (Kristian Munkerud et al., 2007a).

To address these issues, the industry has been exploring alternative methods to improve efficiency and reduce expenses. One such alternative approach that has gained traction in recent years is the use of Riserless Light Well Intervention (RLWI) technique. RLWI performs subsea well intervention without using a drilling riser package and a subsea BOP. Alternatively, the Well Control Package (WCP) will be installed on top of subsea Xmas Tree as a barrier replacing BOP and then downhole tools can be deployed into the subsea well utilizing wireline from intervention vessel (Nugroho, n.d.).

In this way, RLWI has a notorious advantage over conventional riser-based approach, due the use of lighter equipment and smaller vessels, which implies in cost and operational time saving. RLWI techniques have shown significant promise in reducing intervention costs for oil companies, representing a cost saving of approximately 40-50% in recent years (Fjaertoft & Sønstabø, 2011). This method eliminates the need for expensive riser systems, making the intervention process more streamlined and cost-effective.

A configuration of a RLWI stack can be seen in figure 1. In this setup, the PCH (Pressure Control Head) provides the grease seal function and serves as a primary well barrier, ULP (Upper Lubricator Package) cuts the wireline string in case of emergency, has the grease circulation outlet and a connection hub for the PCH, LT (Lubricator Tubular) act as a storage or parking facility for the intervention tools, LLP (Lower Lubricator Package) allow the control of the RLWI stack and the WCP (Well Control Package) is the main mechanical safety barrier of the RLWI stack (Arvind Keprate & Mohammed Ali Mohammed, 2016).

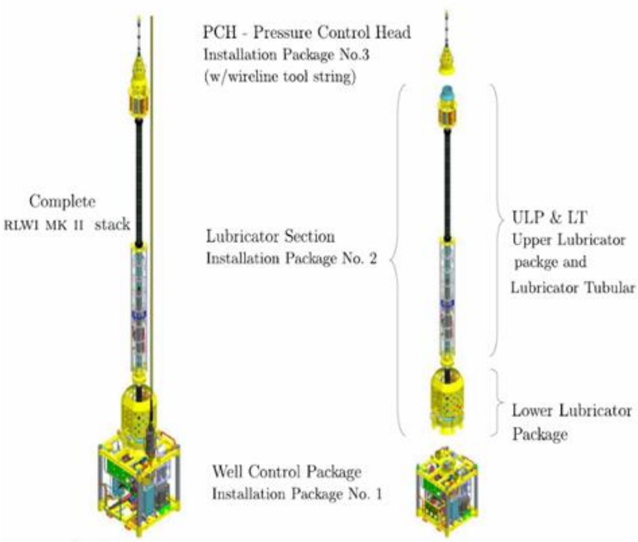

Figure 1: RLWI Stack.

Source: Arvind Keprate & Mohammed Ali Mohammed (2016) apud FMC Technologies (2013).

The objective of this work is to provide a comprehensive review of RLWI techniques and the current advancements in research related to this subject. To achieve this, an initial bibliometric search was conducted to understand the metrics and the current volume of scientific works and patents on RLWI. The most relevant studies and patents were then analyzed and discussed in detail.

Methodology

To find data to support the literature review on RLWIs, an iterative method was employed. As relevant texts were identified, metadata analysis was performed to refine the search and find texts aligned with the research objective. The search for scientific works was performed with use of the terms "Riserless Light Well Intervention" OR "RLWI" in Scopus, Google Scholar, and Onepetro databases. Additionally, a filter was applied to include only English-language texts published from the year 2000 onwards. This initial review resulted in an amount of 801 works on this subject.

The metadata extracted from the search on these bases were further analyzed using Bibliometrix, a software dedicated to metadata analysis of scientific articles. Subsequently, titles and abstracts were analyzed to determine if the content aligned with the current study's interests. In figure *2* this methodology is summarized.

Figure 2:Methodology of research.

Source: The authors.

Interestingly, the "Word Cloud" feature (Figure *3*) revealed that a significant portion of the identified texts included keywords such as 'Abandoned Well' and 'Drill,' which are not relevant to the current study.

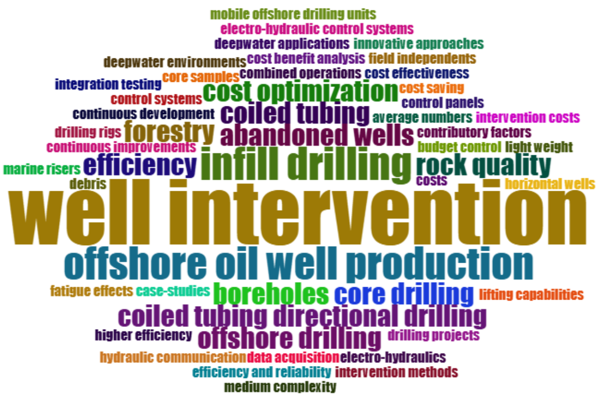

Figure 3: Word cloud.

Source: The authors.

Subsequently, the keywords were modified to [“Riserless Light Well Intervention” OR “RLWI” not “Plug” not “Drill”]. However, this significantly reduced the number of retrieved works. Consequently, the keywords were further adjusted to [“Intervention” OR “RLWI” not “Plug”]. The resulting texts were selected based on their titles and abstracts. Additionally, to complement the identified articles, searches were conducted using the keywords [“Riserless Light Well Intervention” OR “RLWI” AND (“robot” OR “automation”)], resulting in a final amount of 9 works which were relevant for this article.

Results and Discussion

Correa et al. (2017) brought to the discussion the comparison of RLWI with Intelligent Completion and Intervention Robot, where the intervention robot is an equipment that has several devices at its base to perform various forms of intervention. Intelligent Completion, in turn, is a set of controls composed of sensors and actuators to control oil production, with the disadvantage of tending to lose communication in extreme environments. Therefore, they concluded that the use of RLWI in conjunction with robots can solve most well interventions.

Varne et al. (2017) shed light on trends in areas that have recently been developed and will develop in RLWI, making it clear that the success rate of these technologies is still low but tends to become more effective as the technology matures. For example, WCO eliminates the need of circulation fluids for cleaning the oil well, using various tools to clean residues produced by the well. Additionally, the completion manipulation system responsible for generating bidirectional axial movements and a traction equipment were also presented. Some improvements have been considered as trends for the future, such as enhancements in aspects like maximum force, depth, and minimum temperature.

According to Carpenter (2014), the mechanical stroker system is built using hydraulic actuators and produces a load greater than 55,000 lbs, which eliminates the need for explosives, thus reducing damage to the well and eliminating the need to deactivate it. Carpenter (2014) also points out the existence of rotary tools for cutting the tubing, further reducing the need for explosives. This work also highlights improvements in connectivity to acquire real-time well information to optimize intervention and the use of computer simulation to mitigate damage to the cabling, as electrical cables are subject to pressure caused by depth and stresses caused by marine currents.

Juel et al. (2009) discussed the use of a tool capable of machining a calcium carbonate ($CaCO_3$) obstruction at high temperatures. The equipment can reliably withstand up to 166°C in usual situations, drilling platforms are used. Juel et al. (2009) highlighted the disadvantage of using RLWI compared to the drilling platform, due to the fact that there is no obstruction caused by the intervention tool. However, it was concluded that a production level similar to the drilling platform can be achieved with RLWI, with a 50% cost saving in operation.

Kristian Munkerud et al. (2007b) cited some technological advances in the riserless intervention area, such as the development of composite materials for the manufacture of the RLWI cable line. With the use of these materials, the cable achieves greater signal transmission capacity, lower weight, lower friction, and greater resistance. With the application of composites such as carbon in the cable line, it is foreseen the possibility of using cables up to 10,000 meters in length. However, this technology still faces challenges, such as the difficulty of joining materials for cable manufacturing, producing a resistant matrix so that the cable can operate reliably at 10,000 meters, and combining compatible materials for operation with the liquids and temperature present in an exploration well.

Conclusions

With the works studied, it could be seen that RLWI presents a new approach to the intervention of subsea wells that can lead to a higher frequency of interventions with more feasible costs. However, this technology still has room for improvement, mainly with the use of robotic solutions associated with this technology. Table *1* abstracts the works discussed in the last section.

Work	Author	Main topics
Intelligent Completion or Well Intervention Robot?	Correa et al. (2017)	- Intelligent Completion has the disadvantage of tending to lose communication in extreme environments; - RLWI with the use of Intervention Robot can solve most wells interventions.
Intervention Campaigns Over a 10-Year Period with Riserless Light Well Intervention Vessels Enables North Sea Operator to Improve Operational Efficiency and Increase Recovery from its Subsea Fields	Varne et al. (2017)	- Some areas in RLWI are still being developed and the success rate of these technologies is still low but tends to become more effective as the technology matures; - WCO eliminates the need for circulation fluids for cleaning the oil well, using various tools to clean residues produced by the well; - The completion manipulation system responsible for generating bidirectional axial movements and a traction equipment were also presented.
Improved Recovery Rate in Subsea Wells by Use of Riserless Light Well Intervention	Carpenter (2014)	- The mechanical stroker system is built using hydraulic actuators and produces a load greater than 55,000 lbs, which eliminates the need for explosives; - Improvements in connectivity to acquire real-time well information to optimize intervention and the use of computer simulation to mitigate damage to the cabling, as electrical cables are subject to pressure caused by depth and stresses caused by marine currents.
Wireline Tractor Milling Operations From a Riserless Light-Well Intervention	Juel et al. (2009)	- Discussed the use of a tool capable of machining a calcium carbonate ($CaCO_3$) obstruction at high temperature;

Vessel at the High-Temperature Åsgard Field		- A production level similar to the drilling platform can be achieved with RLWI, with a 50% cost saving in operation.
Riserless Light Well Intervention (RLWI)	Kristian Munkerud et al., (2007b)	- Cited some technological advances in the riserless intervention area, such as the development of composite materials for the manufacture of the RLWI cable line; - With the application of composites such as carbon in the cable line, it is foreseen the possibility of using cables up to 10,000 meters in length, however this solution has to overcome some technologycal challenges.

Table 1: Abstract of the works studied.

Source: The authors.

Bibliographic references

Arvind Keprate, & Mohammed Ali Mohammed. (2016). Appraising the Module Deployment Operation in the RLWI Units. *Journal of Shipping and Ocean Engineering*, *6*(2). https://doi.org/10.17265/2159-5879/2016.02.002

Carpenter, C. (2014). *Improved Recovery Rate in Subsea Wells by Use of Riserless Light Well Intervention*.

Correa, N. A., Barcelos, T. F., Miura, K., & Mendes, J. R. (2017, November 13). Intelligent Completion or Well Intervention Robot? *Day 1 Mon, November 13, 2017*. https://doi.org/10.2118/188880-MS

Fjaertoft, L., & Sønstabø, G. (2011). *SPE 143296 Success From Subsea Riserless Well Interventions*.

Håheim, S., Hoen, C., Heigre, B., Heim, E., & Windsland, O. (2003). Riserless coiled-tubing well intervention. *Proceedings of the Annual Offshore Technology Conference*, *2003-May*, 1092–1101. https://doi.org/10.4043/15179-ms

Juel, H., Ranum, H., Mjaaland, S., Varne, T., Solberg, D. B., & Bjorndal, R. (2009, March 31). Wireline Tractor Milling Operations From a Riserless Light-Well Intervention Vessel at the High-Temperature Åsgard Field. *All Days*. https://doi.org/10.2118/121481-MS

Kristian Munkerud, P., Inderberg, O., & Technologies, F. (2007a). *Riserless Light Well Intervention (RLWI)*.

Kristian Munkerud, P., Inderberg, O., & Technologies, F. (2007b). *Riserless Light Well Intervention (RLWI)*.

Nugroho, P. (n.d.). *A Study of Wireline and Downhole Position Control for Riserless Light Well Intervention in Deep Water*.

Rosetto, I., Schoener-Scott, M., Etcheverry, C., & Almeida, J. (2001). *Case History: First Coiled-Tubing-Conveyed Live Well Intervention Run From a Semi-Submersible Platform in Brazil to Increase Perforation Length in a Deep Water Horizontal Wellbore*. https://doi.org/10.2118/69519-MS

Varne, T., Jorgensen, E., & Gjertsen, J. (2017). *SPE-185914-MS Sustained Intervention Campaigns Over a 10-Year Period with Riserless Light Well Intervention Vessels Enables North Sea Operator to Improve Operational Efficiency and Increase Recovery from its Subsea Fields*.