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Application Of Hybrid ESP-Gas Lift In Multilayer Carbonate Reservoir Of Ujung Pangkah East Java Offshore Field

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Abstract. Ujung Pangkah Offshore Field as the main oil & gas producing field of Pangkah PSC Block, has been produced from a total of 30-40 wells since 2007. The field has been using gas lift as its main artificial lift method considering the availability of gas rate to be injected and gas lift handling equipment capacity. However, the increase of more oil development wells & oil converted wells since 2019, all renders gas lift injection capacity considerably limited. Based on these constraints, in addition to the unused power availability from gas turbine generator, ESP (Electrical Submersible Pump) is decided to be trialed starting in 2020.

X1 & X2 wells, formerly a gas-lift-enabled oil producing wells, are selected for ESP trial well candidates. These wells are both qualified to install and utilize ESP since these wells have relatively high productivity index and meet ESP artificial lift selection criteria. In addition to the usual ESP components (multistaged pump, motor, power cable, surface control equipment & Variable Speed Drive), gas lift valves inside gas lift mandrels are also installed above ESP system to enable contingent production with gas lift and to ensure the sustainability of well production rate when these ESP components experience trip/failure. To accommodate for ESP operation with pump maximum GOR limitation, these wells are also equipped with AGH (advance gas handler) and gas separator sub to remove free gas from produced fluid through annular venting valve. This annular venting valve & annular packer installations, as part of ESP completion, are one of the requirements to comply with company “well dual barrier policy”.

Application of X1 ESP-GL conversion is conducted in Q3 2020, while X2 is conducted in Q1 2022. Even though it is being trial tested, X1 ESP pump has been running for almost 2 years to this day. Production rate increases with gain more than 348% in comparison to its depleted rate prior to ESP-GL installation, and saving up to 1.2 MMscfd additional gas lift rate capacity. X2 ESP yields gain to 38% of its last rate pre-ESP-GL installation, saving 1.1 MMscfd gas lift rate capacity.

The conclusion is, the installation of hybrid ESP-GL system has been successfully applied in 2 wells in Ujung Pangkah field. For further strategy, another well is planned to be applied with the same hybrid ESP-GL system. Proper installation referring to fluid properties & production rate and proper operational procedure to maintain ESP pump run life is currently a key to maximize production opportunities particularly in limited offshore field.

Keyword(s): esp, gas lift, hybrid esp gas lift, offshore, east java, ujung pangkah

1 Introduction

Pangkah PSC Block is located in East Java, which field development has been commenced since April 2007 with SEI - Saka Energi Indonesia fully holds 100% of the field operatorship. Currently producing field consists of offshore fields, Ujung Pangkah & Sidayu, and an onshore field, West Pangkah, which all mainly producing from Kujung-1 carbonate & Tuban carbonate as its producing reservoir. Both Kujung-1 & Tuban reservoirs are shale-separated, carbonate reservoir; with producing wells typically completed by multilayer completion, cased-hole perforated that target Tuban zone and open hole that target Kujung zone [1]. Illustration for typical wells in Pangkah is shown by Figure 1 below:

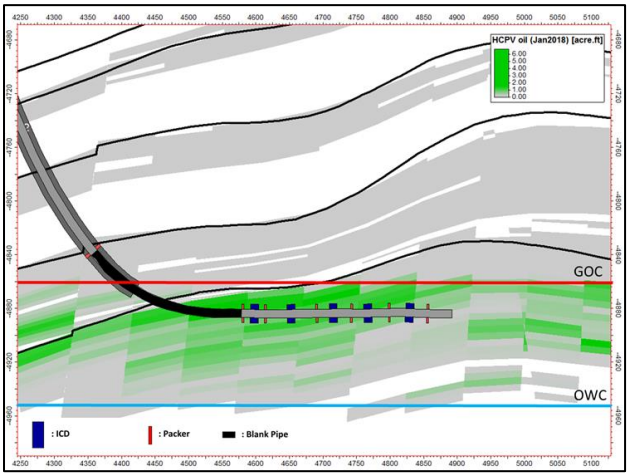

Figure 1 – Typical well design with the ICDs and Packers placement within HCPV Oil [1]

Because of its moderate gas reservoir, as well as its oil reservoir that contains sufficient associated gas, Pangkah Field and most of its development wells has been produced by using gas lift method. Overall production system has been depending on GLC (Gas Lift Compressor), supported by temporary GLC to inject gas lift into the well. However, approaching 2018-2019, gas lift system is considered not optimum anymore, since the total gas lift rate requirement for all wells in 2019 has reached significant amount, on the other hand current gas lift system in Pangkah is only able to deliver 73% of the production. This limitation urges SEI to shut-in some of its producing wells at that time. The recent development on West Pangkah & Sidayu Field requires more gas lift handling capacity for the well to be produced effectively. All these constraints & limitations caused SEI to begin the trial on secondary artificial lift method, ESP (Electrical Submersible Pump). In addition to compressor limitation and the development plan for more wells, Pangkah Field has extra unused electrical capacity from GTGs (Gas Turbine Generators) that can be used as electric source for ESP operation.

2 Electrical Submersible Pump – Selection & Design

In 2020, SEI proposed 2 well candidates in Ujung Pangkah to be trialed with ESP installation. These wells are proposed by considering their significant productivity indexes in addition to both wells meeting ESP installation criteria, including:

- The absence of solid/sand production issue that might hinders ESP performance
- Free gas production from the well is accepted and meet technical criteria
- Economically viable assuming the well has maintained decline rate with minimum 2 years ESP run life

Considering these criteria, both X1 & X2 wells meet with the criteria. However, ESP installation is started in 2020 just for X1 well only, as X2 well at that time has just been intervened to reopen its zone after S/I for some period, causing the production exceeding initial estimation without intervention. Concerns for significant production loss and operational risks are what causing SEI to postpone ESP installation on X2 well. X1 well on the other hand, has been produced using ESP since August 27th 2020 to the end of August 2022. Hence, ESP installation in X1 is considered economic since its run life has just reached 2 years.

For ESP design, Ujung Pangkah ESP installation decides on a “hybrid ESP-Gas Lift” completion design. The concept still relies on ESP as the main artificial lift, but it may return to gas lift method again when ESP gets temporary or permanent shutdown. The design also secures well production for longer time, so that when ESP trip or S/D, the well still can be produced albeit with lower production rate. Typical ESP well completion design for both X1 & X2 well are shown in Figure 2 below:

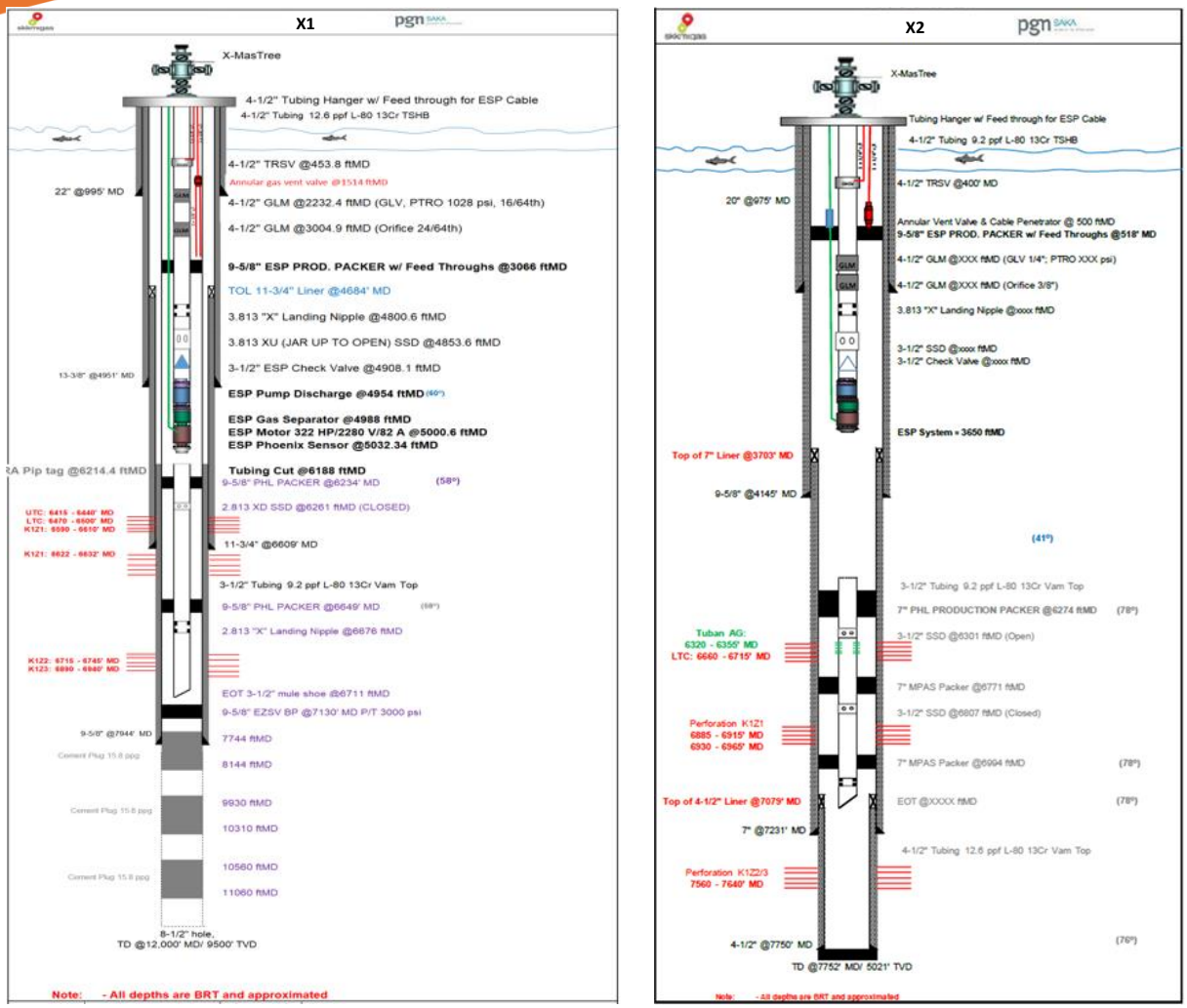

Figure 2 – Typical hybrid ESP-Gas Lift completion design in X1 & X2

From the design above, several notable traits to the usual conventional ESPs are as follows:

Table 1. Comparison of Pangkah Hybrid ESP-Gas Lift completion design to usual ESP design

Traits	Completion Design	
	Pangkah Hybrid ESP-GL	Conventional ESP
Components		
Main component	Multistage pump Induction motor Power cable Surface control	Multistage pump Induction motor Power cable Surface control

GL component	GLM & GLV SSD (sliding sleeve door) Lower GLM/GLV for GL deepening (opt) Landing nipple for some purp. i.e. catcher sub installation (opt)	-
Other component	VGSA/AGH/Gas Separator Gas vent valve/line through annulus ESP packer w/ feed through Check valve above ESP comp.	(opt)
Others		
Run life	ESP + GL run life	ESP run life
Operational risks	Reduced as downtime can be minimized with GL	Typical downtime risk from downhole problem (pump/motor) to electrical problem

Referring to the table above, Pangkah installed, hybrid ESP-GL is not only just ESP components (multistage centrifuge pump, downhole induction motor, power cable, surface control equipment i.e. variable speed drive, trafo & junction box), but also GL component. Several lined GLMs (gas lift mandrels) with GLVs (gas lift valves) inside are installed along with the well completion to utilize gas lift. In addition, the design also ensures to install SSD, just above ESP component, so that when ESP component stuck (especially considering Kujung Carbonate zone that is prone to scale forming), the fluid can still flow through SSD as reservoir fluid intake during gas lift operating system [2]. Lower GLM/GLV can be installed to enable the well to gas-lift-deepened, while landing nipple can be installed for various purpose; in Pangkah case, it can be used to install catcher sub to eliminate risk of GLV fall into hole during GLVCO (gas lift valve change out) operation. Check valve above ESP components is installed to avoid ESP components from breaking or parting from back rotation, as the flowback effect of the fluid in the tubing occurs when ESP trip/stops.

VGSA (vortex gas separator assembly), with AGH (advanced gas handler) and/or gas separator are also installed to unload formation gas and to minimize gas lock risk on ESP. These components are either to dissolve gas into the fluid or to effectively separate free gas away from liquid through annular venting valve. Since Ujung Pangkah field is offshore based, special ESP packer is also installed (with gas vent & cable feed through) for SEI to keep compliance with dual-well barrier policy. SEI is rather strict with safety and environmental concerns that this special ESP packer is installed; free vented gas is flowed through annular venting line to production system instead of being flared.

Another point to be noted is the additional run life from this hybrid ESP-GL design compared to the usual conventional ESP design. When ESP experiences temporary or permanent shut-in, the well can still be operated using GL system that is certain to improve wells run life. Furthermore, the well's downtime & LPO (lost production opportunity) can be reduced by utilizing GL whenever ESP trips temporarily.

3 Results & Discussion

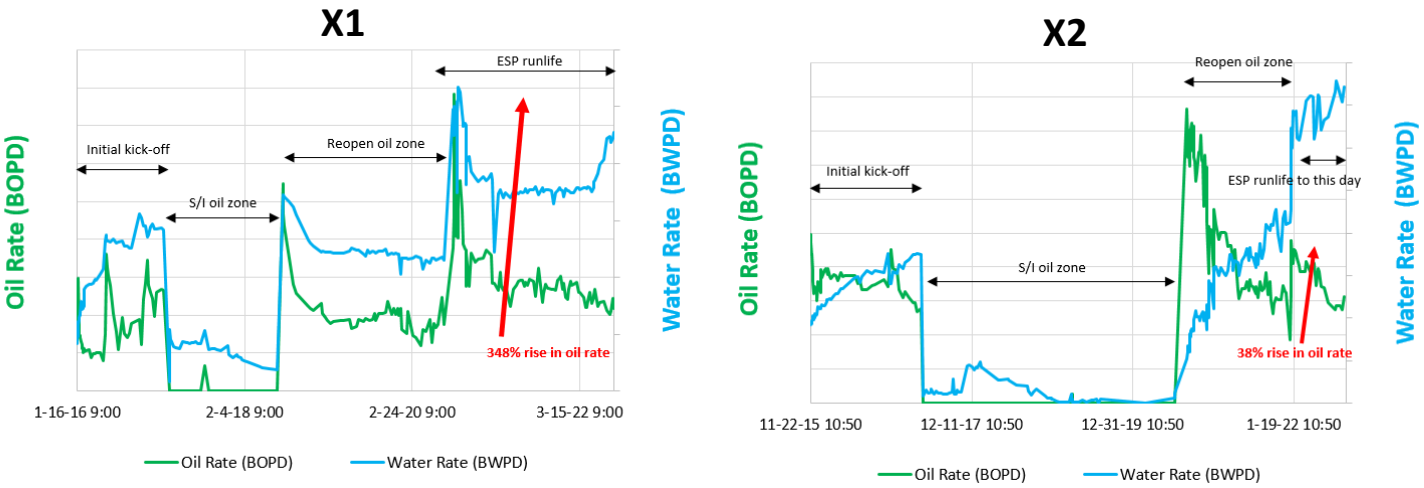

Figure 3 – X1 & X2 Production Trend pre to post ESP installation

Application of X1 ESP-GL conversion is conducted in Q3 2020, while X2 is conducted in Q1 2022. Even though it is being trial tested, X1 ESP pump has been running for almost 2 years to this day. Production rate increases with gain more than 348% in comparison to its depleted rate prior to ESP-GL installation, and saving up to 1.2 MMscfd additional gas lift rate capacity. X2 ESP yields gain to 38% of its last rate pre-ESP-GL installation, saving 1.1 MMscfd gas lift rate capacity. By saving this certain amount of additional gas lift rate capacity, it is possible for SEI to reactivate its previously mentioned shut-in well(s) that potentially can give more production gain.

4 Conclusion

The conclusion is, the installation of hybrid ESP-GL system has been successfully applied in 2 wells in Ujung Pangkah field. For further strategy, another well is planned to be applied with the same hybrid ESP-GL system. Proper installation referring to fluid properties & production rate and proper operational procedure to maintain ESP pump run life is currently a key to maximize production opportunities particularly in limited offshore field.

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