IATMI22-042

# Handling ESP Problem Using Automatic Frequency Rocking (AFR)

Yulianto Agus Setiawan*[1], Marda Vidrianto[1], Roy Arthur[1]
[1]Pertamina Hulu Energi OSES
* Email: yulianto.setiawan@pertamina.com

**Abstract.** The most typical issue with ESP is a gas lock, which causes the system to stop down and need a restart. Due to motor fires, downthrusts, a damaged shaft, and other issues, the gas lock prevents production. Gas-lock is managed by avoiding, decreasing the effect of, and removing it. By employing a gas handler, choking, and venting, gas-lock may be prevented. However, these measures have not entirely prevented the gas-lock. Utilizing Inconel shafts, Hi-Temp motors, and high-quality materials have been attempted to make gas-lock less of a problem, but the issue has yet to be resolved.

The conventional way for removing the gas lock is to switch off the ESP and restart it, however this generates further issues, such as the pump being stuck. In addition, for offshore activities, weather, boat availability, and distance must be considered in order to resume an ESP. Therefore, another way is required to remove the gas-lock without disabling the ESP.

Changing the ESP frequency manually using variable speed drive (VSD) is a typical method for removing the gas-lock without turning off the ESP. By altering the frequency, it is anticipated that the trapped gas will be forced out of the pump by the fluid. However, changing the frequency manually is ineffective for offshore activities. Instead, an automated procedure is required for greater efficiency and quickness. A controller module rather than VSD operator personnel is needed. The controller comprises a PLC, an HMI display, and setup software. The frequency changer is activated by low-ampere, low-Pi, and high-TM plus delay time trigger factors. The frequency-changing process is halted depending on time or other criteria, indicating the elimination of the gas lock. If the sign of gas-lock is recognized, the procedure will resume. This method may be performed several times throughout the day and night. This technique is referred to as Automatic Frequency Rocking (AFR).

The ESP installations at well CINE-09 were observed. The run life of the last four ESP placed in the CINE-09 well is 71 days, 29 days, 39 days, and 335 days following the use of automated frequency changer AFR. The issue with ESP here is again gas lock. The graphical representation of the Ampere, TM, and Pi data depicts a periodic and continuous gas-lock removal process. When the AFR is disabled, a gas-lock develops, causing the TM to increase and therefore shutting the ESP. The AFR application successfully eliminates gas lock on the ESP pump without shutting the ESP. Using the AFR, a basic ESP systems constructed from common materials will be able to tackle challenges in problematic wells.

**Keyword(s):** ESP; gas lock; ESP Problem; frequency; VSD



## 1 Background

PHE OSES is an offshore field that produces 25,000 BOPD from around 300 producing wells with artificial lift ESP. The average ESP run life for all PHE OSES oil wells is 600 days. To maintain production levels,

138 ESP installations (ESP repairs) were performed to offset 148 times DHP (Down Hole Problem/ESP Broken) in 2021. In addition, based on data from 2021, the number of ESP troubleshooting activities is relatively significant, reaching 1,146 per year. The purpose of troubleshooting is to reactivate the ESP after an issue that caused it to trip.

### *1.1 ESP Life Cycle*

The ESP life cycle begins with ESP design. In ESP design, the depth, flow rate, ESP outer diameter (OD), casing inner diameter (ID), voltage, and ESP nameplate are taken into consideration. Next, ESP installation, ESP startup, and ESP operation are performed. If ESP encounters a problem that causes it to trip, troubleshooting is undertaken until ESP can be restarted successfully or it is declared broken (Figure 1).

### *1.2 The Root Cause ESP Trip*

This article will mainly discuss ESP problems. The number of ESP troubleshoot actions is very large, reaching 1146 times due to ESP trips every year (2021 data). Troubleshooting is done as an attempt to make the ESP run again after the ESP tripped due to a problem. The root causes of ESP trips are classified as follows:

- Gas lock (49%)
- Flow Line leaking, project, manual off (24%)
- Electricity, pneumatic, hydraulic (18%)
- Overload (8%)
- Tubing leaking (1%)

### *1.3 Factors Causing ESP Tripped Due to Gas Lock*

Gas problems have become commonplace in old wells, and this has to be faced by the ESP installed in the wells. The gas lock problem is characterized by several symptoms, like no production rate, underload, high motor temperature, low PI, low pressure in wellhead, and low pump discharge.
The factors that make the ESP trip due to gas lock are:

**Environment**

Transport between platforms must be taken by boat. The distance from barge accommodation to P/F can be up to 6 hours by boat. One unit boat is only to serve one area. The boat departure time is set. Because of this, ESP protection due to gas lock must be activated so that it will be tripped when gas lock occurs.

**Methods**

So far, manual troubleshooting has been done. Troubleshoot is done to overcome ESP problems that make the ESP trip or even before the ESP trips. ESP protection is set to prevent U/L conditions from lingering for a long time. The setting is in the form of a lower limit of running amperage and an upper limit of motor temperature. If it exceeds the setting and exceeds the delay time, the ESP will be tripped off.

**Instrument**

There is no new innovation in ESP technology by vendor. The installed ESP technology is the most up to date and sophisticated, there are no new innovations from ESP providers. The ESP series already uses AGH, Rotary gas separator, new impeller design, high grade material. But the gas lock still occurs and requires the ESP to be shut in otherwise it will damage the ESP circuit. Need a new technology to eliminate gas lock.

**Material**

Low PI, High GLR, Sand production. OSES is a block that has long been in production as a result reservoir pressure is low, GLR is increased, and sand is produced. Gas locks are becoming more and more common and require the ESP to be shut down automatically or manually.

**Human**

There is no personnel crew on standby on the platform. Non-process platforms do not have accommodation facilities for crews who will monitor ESP performance on an ongoing basis. The personnel only perform brief and periodic checks on each platform. If there is a problem related to the gas lock problem that can occur at any time, then the only way is to activate the U/L protection so that the ESP will trip when the gas lock problem occurs.

## 2 Solution

A solution to overcome the gas lock without shutting in ESP must be found to prevent the ESP trip, which will result in oil production loss. The following are some possible alternative solutions:

### 2.1 Manual by Crew

Manual troubleshooting is performed by the troubleshooting (T/S) crew that physically present on the platform. This T/S team consists of an ESP Supervisor, a production operator, and an electrician. According to the shift schedule, boat travel is used to reach Platform. This T/S team's mission is to restore the ESP's functionality once it has been disrupted. They must determine if it is feasible to restart the ESP. Then, reset the ESP running protection, such as the underload limit, the overload, the HITM, the tubing pressure, the flowline pressure, and the timing delay. After a restart, the ESP must be regularly checked day and night. Before taking any troubleshooting actions, the T/S team must await a signal from the running ESP.

### 2.2 Realtime Monitoring

An ESP Provider provides a real time monitoring product in which there is a feature called GLM (Gas Lock Management). GLM is embedded into the VSD which will work if there is a gas lock sign. With Liftwatcher running ESP can be monitored via SCADA or via satellite. A personnel is assigned to monitor one or more ESPs where the personnel will take action if it is known that the ESP running parameters are not at the previously set limits.

### 2.3 Automatic Frequency Rocking (AFR)

AFR is one of the features on the VSD controller tool. The main principle of AFR is to change the VSD frequency automatically when gas lock symptoms are detected. The VSD controller in which there is an AFR feature is a module in the form of a display and a PLC as the main instrument. The touchscreen display allows setting the frequency change pattern. Setting this frequency pattern to suit the character of individual wells. This means that if a pattern of frequency changes does not succeed in controlling the gas lock, then another pattern can be made so that it can eliminate the gas lock effectively. Those who determine the pattern of frequency changes are operators who have received training.

Evaluation with consideration of cost, delivery, effort, impact, risk, and reliability, then AFR was chosen for an effort to control gas lock on the ESP more effectively so as to reduce the number of tripped ESPs. This alternative solution that we choose to implement.

### 2.3.1 AFR Feature

AFR is embedded in the VSD controller. The main instruments of the VSD controller are PLC, HMI Display touchscreen, Software, and the casing module so that the VSD controller is more compact and plug and play (figure 1). The following is a description of the application features on the intended VSD controller.

**Start Up Control**

Normal Start Up, Control Rocking Start, start up ampere graph display, emergency shut down

**ESP Running Monitor**

Actual data of ESP running parameter, Graphic of Ampere, BHT, BHP, Pdisc, Pwh, Pcsg, Rate

**ESP Protection**

ESP Protection Setting, Automatic Action to Protect ESP - O/L, U/L, high TM, loss flow, Well Fluid Level Display

**Well Test Program**

Programable well test operation - PBU, Drawdown, and Multi Rate Test methods, collect data for finding skin number, P*, drainage area

**Remote and Onsite Operation**

Capable for remotely setting, download, and command. (SCADA/ GSM / Satellite), Onsite setting, download, and command with connector RS 485, USB, Camera

**Rocking Gas Lock & Pump Off Protection**

Automatic rocking Gas Lock setting, Pump Off Protection. Basically, this feature that we discuss in this article. Rocking gas lock can be set automatically or manually.

## 2.4 AFR Implementation

The VSD controller is connected to the VSD. The AFR capability has been added as one of the VSD controller's features. The VSD controller enables the VSD frequency to be changed automatically if the ESP running parameter value exceeds the limit and delay time settings. AFR controllers may include HMI, PLC, and software. The display is viewable from the front for simple configuration and power supply with a 220-volt inverter as the primary frequency-changing device. Figure 3 shows how the AFR System memory controller can be used to get all of the ESP parameters that have been found.

AFR implementation was performed on the BTCE-09 well. Since 2019, there have been four ESP installations on BTCE-09. ESP is implemented by a variety of manufacturers and varieties. A few days after commissioning, ESP suffered a gas lock issue and had to be turned down and restarted. The previous installation demonstrates that the ESP experiences gas lock at the start of the first run following startup. Startup uses VSD to regulate the frequency in order to avoid ESP underload and motor temperature rise. This underload and the rising motor temperature are clear indications that the ESP has gas locked. The only method to remove the gas lock is to manually or automatically deactivate the ESP. Due to the repeated starting and stopping, the ESP ultimately fails after a brief productive period. The BTCE-09 will have the AFR module installed in order to avoid the gas lock without shutting down the ESP. The AFR module will circumvent the gas lock without turning off the ESP.

The AFR has been set to automatic. The AFR will work when the ESP Protection setting, which is intended to trigger the AFR to work, has exceeded the setting limit. The settings are a combination of frequency and time delay. When the ESP is hit by a gas lock and the protection parameter limit is reached, the AFR will work. The way it works is by changing the frequency according to the settings (Figure 4). The frequency

will change, up and down, according to the setting pattern. After the time duration is over, the VSD or ESP frequency returns to the original or according to the final frequency setting. In order to get ready for the ESP to stop pumping, the final frequency can be set lower than it was before.

From the graph of the running ESP parameters (Figure 6), it can be seen that AFR works quite often. This indicates that gas lock often occurs in the ESP in the well. This time, the parameter used to trigger the AFR is the motor temperature. After the AFR works and displaces the gas, the ESP will run back to normal. If the motor temperature increases again, the AFR will work again, so it will be repeated every time a gas lock occurs. As shown in Table 1, with the use of AFR, the ESP running life increased sharply. As in Figure 6, when the AFR implementation was removed, it could be seen that the gas lock elimination process stopped running until the temperature increased. ESP finally shuts down and must be restarted.

## 3 Conclusion

The following are some conclusions that can be drawn from the use of AFR.

- AFR enable control VSD Frequency
- Automatic Frequency Rocking proven to be able to alter frequency automatically as setting when activated
- Automatic Frequency Rocking proven to be able to release gas lock problem
- Releasing gas lock automatically using AFR prevent ESP shut in
- Releasing gas lock automatically using AFR can extend ESP running life significantly

## References

[1] Brown, K. E., et al. The technology of Artificial Lift Methods – Vol. 2b. Petroleum Publishing Co., Tulsa, Oklahoma, 1980.

[2] Santoso, B. T., Priyandoko, P., Harahap, B., Gas Lift Hybrid Application in Offshore Northwest Java Production Sharing Contract. SPE 65556

[3] Kusumamulya, K., Recycle System to Extend ESP Run Lives, SPE Gulf Coast ESP Workshop, Apr 29, 1998

[4] Agus, Yulianto, New Way of Method to Deal with ESP Problem, SPE Workshop Astana Kazakhstan, SPE-172300

## Figures and Tables

Table 1. Running Life ESP in CINE-09

| Install Date | ESP Type | Instrument | Running Life |
|---|---|---|---|
| 21 Jan 2019 | RCD1000 NX//159/75/ 1797/27.3 | VSD | 71 |
| 22 Dec 2019 | RCD1000 NX/159/75/1797/27.3 | VSD+ GLM | 29 |
| 31 May 2020 | FLEX 3.2/289/ 132/ 2910/ 29 | VSD | 39 |
| 10 May 2021 | QN08/142/80/1213/43/55Hz | VSD + AFR | 231 |
| 16 Jul 2022 | QN08/142/80/1213/43/55Hz | VSD + GLM | 62 |

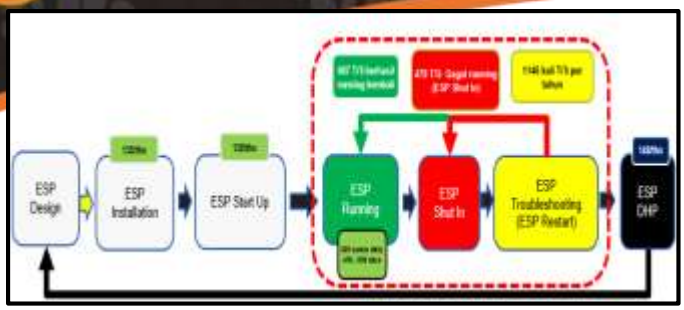


Figure 1. ESP Cycles

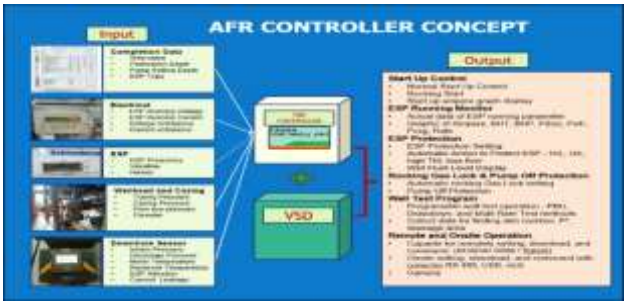


Figure 2. AFR Controller Concept

Figure 3. Module AFR Controller

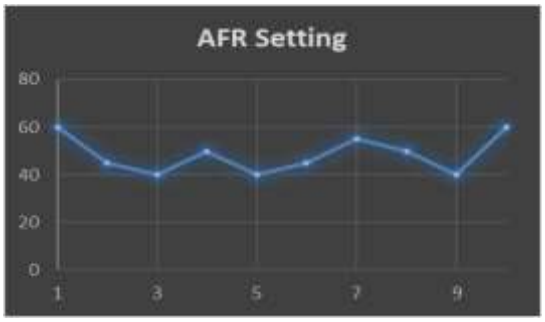


Figure 4. AFR Setting for Gas Lock Protection Setting


Figure 5. Graph profile when gas lock and AFR active

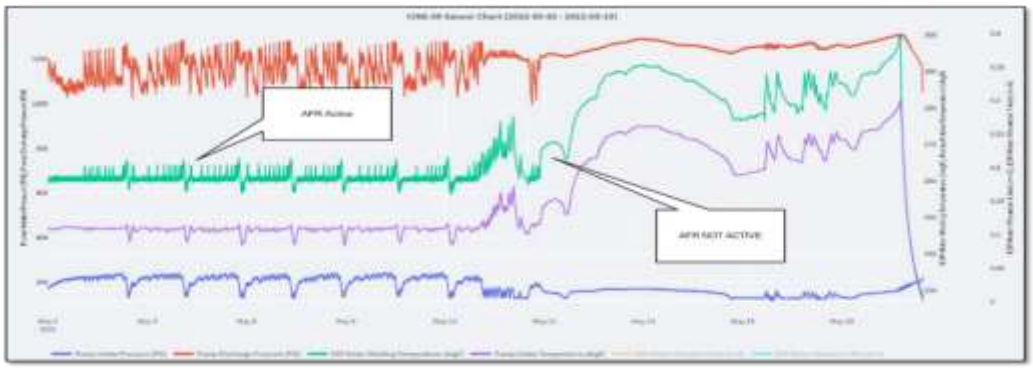

Figure 6. Graph profile when gas lock AFR working and AFR not working