

The Application of Permanent Magnet Motor on Electric Submersible Pump in X Well

(Penerapan Motor Magnet Tetap Untuk Pompa Celup Listrik di Sumur X)

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Abstract

In this research the application of permanent magnet motor and asynchronous motor in X Well was evaluated. The permanent magnet motor and asynchronous motor used in this research are PM51 – NFO 150 FLT @50hz and AM51 – NFO 150 FLT @50hz, respectively. Several parameters are compared such energy losses, energy consumption, motor heating, and production rate. Based on the data analysis, there are some advantages by using permanent magnet motor which can help to improve efficiency and consume less energy, therefore can give more profit within the same period of production. These advantages consist of durability for motor, consume less electricity energy to maintain the operation of ESP string, give bigger production rate, and longer expected life time than an asynchronous motor. The implementation of permanent magnet motor is recommended in oil well that has high fluctuation in production flow rate, since the setting flow rate of the motor is adjustable. This advantage can be useful to give longer lifetime and hence to reduce the pump replacement program.

Keywords: ESP, Performance, Load, Permanent Magnet Motor, Asynchronous Motor

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Dalam penelitian ini dievaluasi penerapan motor magnet permanen dan motor asinkron di Sumur X. Motor magnet permanen dan motor asinkron yang digunakan dalam penelitian ini masing-masing adalah PM51 - NFO 150 FLT @ 50hz dan AM51 - NFO 150 FLT @ 50hz. Beberapa parameter dibandingkan seperti kehilangan energi, konsumsi energi, pemanasan motor, dan tingkat produksi. Berdasarkan analisis data, ada beberapa keuntungan dengan menggunakan motor magnet permanen yang dapat membantu meningkatkan efisiensi dan mengkonsumsi lebih sedikit energi, sehingga dapat memberikan lebih banyak keuntungan dalam periode produksi yang sama. Keuntungan-keuntungan ini terdiri dari daya tahan untuk motor, mengkonsumsi lebih sedikit energi listrik untuk mempertahankan operasi string ESP, memberikan tingkat produksi yang lebih besar, dan waktu hidup yang lebih lama dari motor asinkron. Penerapan motor magnet permanen direkomendasikan dalam sumur minyak yang memiliki fluktuasi tinggi dalam laju aliran produksi, karena laju aliran pengaturan motor dapat disesuaikan. Keuntungan ini dapat bermanfaat untuk memberikan masa pakai yang lebih lama dan karenanya mengurangi program penggantian pompa.

Kata-kata kunci: ESP, Kinerja, Muatan, Motor Magnet Permanen, Motor Asinkron

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I. INTRODUCTION

The development of the petroleum industry today has experienced a lot of progress compared to the petroleum industry in earlier times in the 1970s. The tools used today are experiencing a lot of technological advances and carried out a lot of development in order to pursue better production and minimize the existing risks.

As happened in the development of technological advances in the Electric Submersible Pump (ESP) that is used today has a permanent magnet (PM) in the movement of the motor compared to ancient times which only uses a coil that is electrified for motor movement or we call it an Asynchronous Motor. This is done because a lot of energy is wasted on the use of asynchronous motor, so it is considered necessary to develop

technology to minimize the energy wasted due to this process [1].

Throughout the course of this technology, several evaluations of PM motor were carried out and found several other advantages that need to be considered sufficient compared to the use of asynchronous motor. This has finally become a selling point in the use of PM motor in ESP operations in the world, and finally it is also used in the “Y” field, Indonesia. In this case, the study was conducted by evaluating the use of asynchronous motors in some previous production wells, and ESP installations with Permanent Magnet Motors were installed in these wells for a fair analysis and to determine which motors have higher efficiency and productivity to be able to use in other wells. An evaluation is also carried out to determine the

operational costs required for each motor, and it is necessary to consider a production program for other wells in the “Y” field [2-5].

II. METHOD

This research is carried out with various stages of activity. The procedure of the research is shown in Figure 1.

The stages of work in this study were to evaluate the ESP with an asynchronous motor with a period of 6 months of previous performance on a well that had been planned for ESP installation with a Permanent Magnet Motor. Then an ESP design calculation analysis is performed that matches the requirements of the well as provided in Table 1.

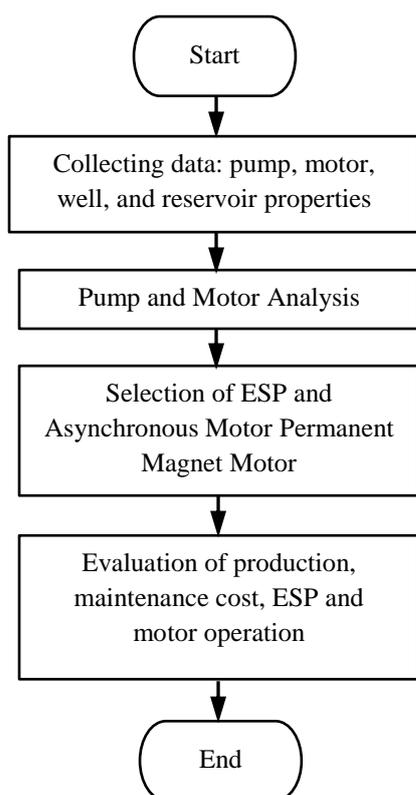


Figure 1. Pump and Motor Evaluation

After performing the design determination in accordance with the well, the permanent magnet motor was installed to be able to do the production process with the same operation period as asynchronous motor. The data used were obtained by recording all parameters of electric submersible by asynchronous motor on the previous period and permanent magnet motor as the current period of time. First, Data of the well condition and the fluid parameter of the well were analyzed. Then, the ESP string which was suitable for lifting fluid into surface condition based on fluid and well parameters was determined. Energy

consumption of the pump and motor were also considered. The obtained data are presented in Tables 2 and 3.

Table 1. Well Data Parameter

Parameter	
Static Pressure (P_s), psi	499
Bottom Hole Flowing Pressure (P_{wf}), psi	259
Flow Rate, bfpd	121
Bottom Hole Temperature (T_{bh}), °C	79
Wellhead Pressure (P_{wh}), psi	100
Water-cut (WC), %	10
Specific gravity water (SGW)	1.01
Specific Gravity oil (SGO)	0.8
Gas Liquid Ratio (GLR)	769
Target rate, bfpd	150
Pump Intake Depth, m MD	1440

After that, the performance of permanent magnet motor was evaluated and compared with the performance of asynchronous motor that had been applied in the previous period of time. After that the data were compared to know the advantages and drawbacks of the motor types.

III. RESULTS AND DISCUSSION

Based on the evaluation, the application of permanent magnet motor had several advantages compared with asynchronous motor such as the durability of motor, energy losses, energy consumption, motor heating, and production rate.

The comparisons between asynchronous motor (AM51 – NFO 150 FLT @50hz) and permanent magnet motor (PM51 – NFO 150 FLT @50hz) performance are indicated in Tables 2 to 5. Based on Tables 2 and 3 the permanent magnet motor caused higher production rate and lower maintenance cost than asynchronous.

Based on Table 4, the total energy losses of permanent magnet motor was about half as high as the asynchronous motor. Table 5 shows that the permanent magnet motor required a lower energy consumption to maintain the operation of ESP string. Other information shown in Table 5 is the permanent magnet motor underwent less heating than the asynchronous motor. It may affect the life time of the motors.

Furthermore, the advantage of the application of permanent magnet motor is the production rate of the motor can be adjusted. For some wells which have fluctuation in flow rate, this advantage can be useful to give longer lifetime and to reduce the pump replacement program.

The comparison of energy consumption between asynchronous motor and permanent magnet motor is shown in Figure 2. The figure shows that less electrical current required for permanent magnet motor than asynchronous motor

to produce load horsepower within the range of studied.

Table 2. Asynchronous Motor (AM51 – NFO 150 FLT @50hz) Operation Parameter

Parameter	
Running ampere	10.4 A
Load ampere start up	16.8 A
Max Ampere	15.7 A
Lifetime	5-7 years
Power factor	0.8
Lifting Cost	5.1 \$/bbl
Electricity consumption	22.715 Kwh
Maintenance cost	USD 740
Tubing Head Pressure	40 psi
Range Frequency	50-55 hz
Range Production	130-160 bfpd
Production tested	138 bfpd
Watercut	70%
Average Net Production	41.4 bopd
Length Motor	4.2 m
Series/ OD	460/ 4,6 inch

Table 3. Permanent Magnet Motor (PM51 – NFO 150 FLT @50hz) Operation Parameter

Parameter	
Running ampere	8.8A
Load ampere start up	12.4 A
Max Ampere	15.7 A
Lifetime	10-12 years
Power factor	0.95
Lifting Cost	4.4 \$/bbl
Electricity consumption	16.186 Kwh
Maintenance cost	USD 528
Tubing Head Pressure	45 psi
Range Frequency	40-60 hz
Range Production	122-178 bfpd
Production tested	152 bfpd
Water-cut	70%
Average Net Production	45.6 bopd
Length motor	3.5 m
Series/ OD	460/ 4.6 inch

Table 4. Energy Losses of Asynchronous Motor Permanent Magnet Motor

No	Energy Losses	AM	PPM
1	Losses in stator winding, hp	11.2	10.4
2	Losses in motor, hp	7.1	0
3	Losses in steel, hp	3.9	0.9
4	Mechanical losses, hp	1.3	0.8
5	Hydraulic losses, hp	1.0	0.8
6	Additional losses, hp	0.8	0.3
	Total losses, hp	25.3	13.2

Table 5. Ratio of Asynchronous Motor to Permanent Magnet Motor

No	Parameter	AM	PPM
1	Operating Current	1.0	0.85
2	Power Factor	1.0	1.14
3	Idle Current	1.0	0.85
4	Power Consumption	1.0	0.9
5	General Losses	1.0	0.5
6	Motor Heating	1.0	0.8
7	Motor Length	1.0	0.6

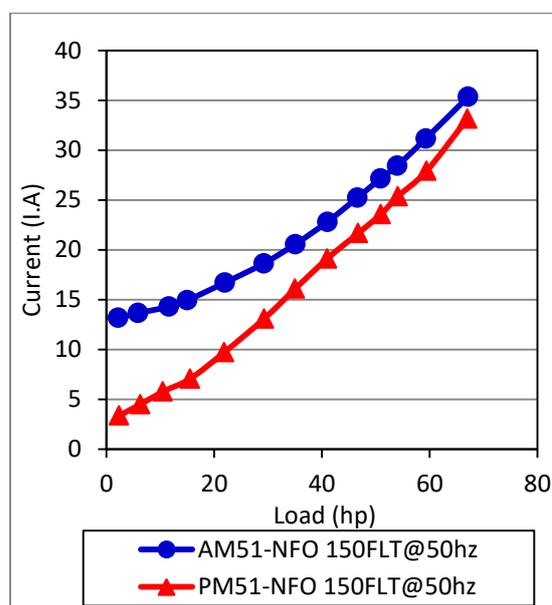


Figure 2. Current vs Load of Asynchronous Motor and Permanent Magnet Motor

IV. CONCLUSIONS

The conclusions of the research are as follows:

1. Research on both types of motor proves that using a permanent magnet motor provides better efficiency energy than an asynchronous motor.
2. This study confirms that the application of permanent magnet motor is able to operate in a production range.
3. Lifetime provided by a Permanent magnet motor is about two times longer than lifetime of an asynchronous motor.

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