PRODUCTION ENHANCEMENT USING MULTIPHASE PUMP

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To my beloved parents and fellow classmates

Thank you for your continuous support

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ABSTRACT

All around the world, oil companies are facing more difficult scenario to produce oil such as brownfield and deepwater development. These scenario provide a good opportunity for the utilization of multiphase pump which provide a cost effective solution to the field development. Multiphase Pump provide incremental oil by reducing the backpressure imposed on the well, allowing it to produce at lower FBHP and thereby enabling higher drawdown to the well. Today there are several types of Multiphase Pump available in the market including Surface Jet Pump, Twin Screw Pump and Roto-Dynamic Pump with its own suitability and limitation. The study consist of literature reviews on actual field application of multiphase pump and provide a guideline based on the usage of multiphase pump. The study also include a Nodal Analysis and Network Modelling study to evaluate the amount of incremental oil from the usage of multiphase pump and provide the most suitable reservoir and facilities condition for the use of multiphase pump. The study concludes that multiphase pump has high potential for production enhancement application. Based on the study, multiphase pump is able to provide 9-50% incremental oil production.

ABSTRAK

Syarikat minyak di serata dunia kini berhadapan dengan cabaran mengeluarkan minyak seperti projek penghidupan semula dan projek laut dalam. Senario-senario ini memberi peluang kepada penggunaan pam pelbagai fasa yang memberi pengeluaran minyak yang kos efektif. Pam Pelbagai Fasa (MPP) menambah bilangan minyak dengan mengurangkan tekanan balik yang dihadapi telaga-telaga minyak sekaligus memboleh telaga-telaga tersebut beroperasi pada tekanan mengalir bawah tanah yang rendah dan menambah perbezaan tekanan antara takungan dan tekanan mengalir bawah tanah. Pada hari ini, terdapat beberapa jenis MPP terdiri daripada Pam Jet, Pam Skru Kembar dan Pam Dinamik yang memiliki kesesuaian dan kekurangan masing-masing. Kajian ini menyediakan panduan berkenaan penggunaan MPP berdasarkan kajian simulasi dan aplikasi MPP di serata dunia. Kajian ini juga menjalankan Analisa Nod dan Pemodelan Jaringan untuk menilai jumlah minyak yang bertambah daripada penggunaan MPP. Kajian ini menyimpulkan bahawa MPP memiliki potensi yang tinggi untuk kegunaan penambahbaikan pengeluaran minyak. Berdasarkan kajian ini, MPP mampu menambah 9-50% pengeluaran minyak bagi sesebuah projek.

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LIST OF ABBREVIATION

ABBREVIATIONS	DEFINITION
MPP	Multiphase Pump
HAP	Helico-axial Pump
SJP	Surface Jet Pump
TSP	Twin Screw Pump
GAP	General Allocation Package
MBAL	Material Balance
IPM	Integrated Production Module
VLP	Vertical Lift Performance
IPR	Inflow Performance Relation
FDP	Field Development Plan
FBHP	Flowing Bottom Hole Pressure
THP	Tubing Head Pressure
WC	Watercut
GVF	Gas Volumetric Factor
EUR	Expected Ultimate Recovery
RF	Recovery Factor
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
MOV	Motor Operated Valve
CPP	Central Processing Platform
WHP	Wellhead Platform
GOR	Gas Oil Ratio
FVF	Formation Volume Factor
EOS	Equation of State
STOIIP	Stock Tank Oil Initially In Place
GIIP	Gas Initially In Place

CHAPTER 1: INTRODUCTION OF STUDY

1.1 Background of Study

Based on Inflow Performance (IPR) and Vertical Lift Performance (VLP) relation, incremental oil production from well is available either through improving reservoir and wellbore condition, supplementing reservoir pressure or increasing the well drawdown by reducing the Flowing Bottom Hole Pressure (FBHP). Currently, various advanced technology are currently available to achieve this mean, ranging from artificial lift such as acid stimulation and downhole pump for water injection or using Enhanced Oil Recovery (EOR). This study focused on one of the available techniques today which is the use of Multiphase Pumps (MPP) technology.

Multiphase Pump provides incremental oil by reducing the backpressure imposed on the well, allowing it to produce at lower FBHP and thereby enabling higher drawdown to the well. The higher the drawdown the MPP can support, the higher will be the incremental oil that can be gained from the well.

Today there are several types of Multiphase Pump available in the market including Surface Jet Pump, Twin Screw Pump and Rotodynamic Pump. All these pumps have their own suitability and limitation and should be selected appropriately according to the oil company reservoir and facilities condition.

1.2 Problem Statement

Multiphase pump technology was developed in the early 90's. Although hundreds of Multiphase Pump (MPUR Survey, Scott, 2002) have been installed around the world, the technology is still not widely accepted in Malaysia. This reluctance is due to lack of industry understanding on Multiphase Pump. Compared to downhole pump such as Electrical Submersible Pump or Hydraulic Pump, the industry has always associated surface pump as single phase pump. The industry also lack in understanding that there are various type of multiphase pump each with its working principles and capability. All these contribute to the poor acceptance of multiphase pump in the industry.

Another reason for the poor acceptance of multiphase pump is the misplacement of evaluating multiphase pump to the facility engineer rather than putting it in the subsurface engineer work scope. While it is true that among the function of multiphase pump is to transport multiphase fluid from one place to another, it can also be used for production enhancement purposes and thereby provide incremental oil to the oil company. The pump function to provide incremental oil is under the work scope of the subsurface engineer and not under the facility engineer.

The slow development of multiphase pump is also due to the fact that it was originally developed for subsea and land application. Both of these applications are usually associated with long distance tie-back to host platform either due to remote area or deep water and does not have space limitation.

Although numerous literature have been published on the success of multiphase pump application in providing incremental oil, and some literatures even claim that the breakeven for the cost of installing the multiphase pump was reached in a matter of weeks or months (Grimstad et. al; 2004), there is clearly a lack of guidelines for Multiphase Pump application. This lack of guideline is clear when compared to text book in universities which expose students and upcoming petroleum engineers to only downhole pump and no mentioning on multiphase pump.

1.3 Objectives

The success stories of multiphase pump application serve as basis that perhaps there is a specific condition where application of multiphase pump should be considered and could provide a significant benefit to oil and gas projects. These factors includes:

- Reservoir condition such as the drive mechanism, water-cut and pressure depletion
- Facilities development concept such subsea or topside development, pipeline distance and water depth

There are also various type of multiphase pump which should be considered, each with own limitation and capabilities.

This study set three (3) objectives that will provide an answer to the problem statement identified in the previous section:

1. Identify working principles of different type of Multiphase Pump
2. Provide recommendation on Multiphase Pump application based on current practice
3. Provide recommendation on Multiphase Pump application based on simulation study

1.4 Contribution to Community

All around the world, oil companies are facing more difficult scenario to produce oil. The same situation will also be faced in Malaysia. The first challenging scenario is brownfield development whereby the oil companies are required to produce the remaining oil from the field after the previous Production Sharing Contract expires. This type of project requires the oil companies to come up with solution to increment field production either through high cost activity such as infill drilling and water injection or quick-gain activity such as artificial lift and behind casing production. Multiphase pump is a type of artificial lift and therefore will provide solution to the challenge faced by the oil companies for brownfield environment.

The second challenging scenario that is faced by oil companies is in deepwater projects. More and more deepwater projects are expected to be announce in Malaysia as "easy oil" is nearing its end. For deepwater projects, oil companies need to re-evaluate the conventional oil production system. A more effective production system may be represented in subsea development whereby the company do not require a platform. Another development concept is building satellite subsea field with tie-in to a giant central processing platform as was the tendency in most deepwater area such as the North Sea or Gulf of Mexico. This scenario provide a good opportunity for the utilization of multiphase technologies which originally develop for subsea application.

Although the potential for multiphase technologies is becoming higher, there are only limited literature and guideline relating to the technology. Most of the guidelines for artificial lift are related to gas lift or downhole pump services. It is therefore the intention of this study to provide a guideline for a topside artificial lift which is multiphase pump. This guideline will then be beneficial to the oil and gas community especially in Malaysia which will face the challenging scenario mentioned above.

1.5 Work Scope and Methodology

The study aims to combine conceptual discussion on multiphase pump, real field application and software simulation in order to achieve its objective. The following flow chart describe the methodology used for the study:

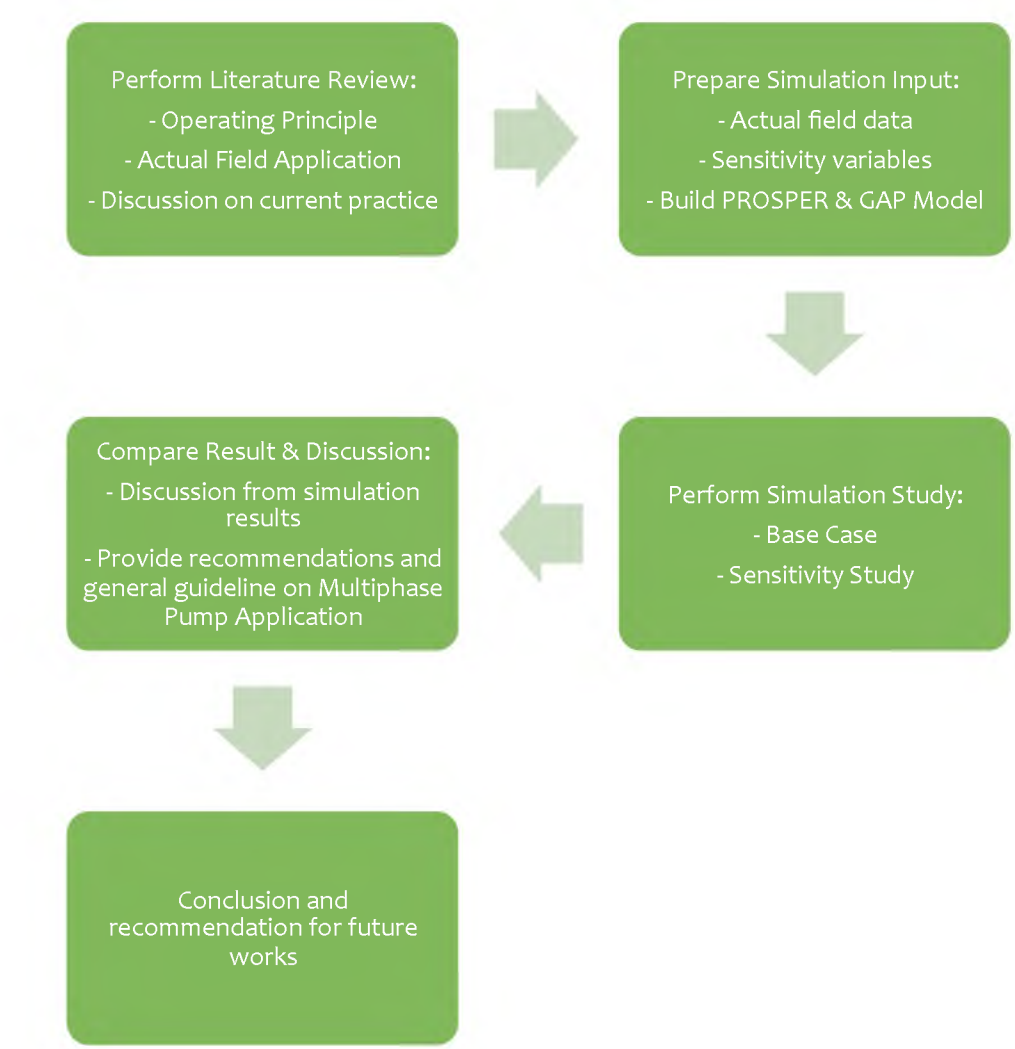

Figure 1.1: Study Methodology Flow Chart

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