UNIVERSITI TEKNOLOGI MARA

CROSSFLOW DETECTION FOR PRODUCTION ALLOCATION USING SPINNER, SPECTRAL NOISE AND TEMPERATURE MODELLING IN EAST MALAY BASIN

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ABSTRACT

Crossflow exists when there are zones with dissimilar pressure properties allowed to communicate during production. Reservoir fluid from a high-pressure zone will flows preferentially to a low- pressure zone except if the production parameters are well controlled. A poor cement bonding often added to this problem by creating unwanted conduits behind casing that leads to crossflow between multi-layer of producing reservoirs. For reservoir monitoring, a conventional Production Logging Tool (PLT) that consists of mechanical spinners is routinely run to perform quantitative assessment of each sand's contribution for production allocation in Malay basin fields. However, detecting, and quantifying crossflow behind casing is impossible using the conventional PLT as the tool is deployed inside the casing. Thus, advanced additions to the conventional production logging tools using High Precision Temperature (HPT) and Spectral Noise Logging (SNL) were introduced to address the issues. These tools are normally run separately. Therefore, the main goal of this research is to study the effectiveness of performing the PLT-HPT-SNL in a single run via tandem mode for the crossflow detection. The first aim of this research is to study the effectiveness of PLT-HPT-SNL logging in detecting crossflow behind casing as reported by previous researchers; through data comparison recorded by the tools in different tools combination runs. Based on the findings of the reported case studies, it is feasible to infer that HPT-SNL logging can be used to diagnose crossflow in the Middle East area, specifically Abu Dhabi and Iraq fields. As the stratigraphy and geological environment in the Malays basin's reservoirs are different from the ones in the Middle East, this research specifically focused to study the feasibility of using HPT-SNL and PLT-HPT-SNL tools to detect crossflow and quantify zonal allocation in Malay basin field. According to observations from the study, the PLT-HPT-SNL combination delivers more valuable information and better data for understanding crossflow and production allocation. The PLT-HPT-SNL tools accurately determine crossflow in the deep reservoirs based on the spinner response and reading from the PLT sensors, supported with temperature modelling and spectral noise anomalies, which resulted in more accurate zonal allocation for each of the reservoirs. The last objective of this study is to validate the PLT-HPT-SNL data interpretation against production separator data on the surface platform. The results of the study also suggested that PLT-HPT SNL results is comparable to surface production data with range of 90% accuracy for most of the reservoirs except for crossflow zones intervals. The major difference of zone allocation between the PLT-HPT-SNL and production separator can be seen especially on the total gas production of shallow reservoirs approximately 3720 Mscf/d versus 176 Mscf/d respectively that is due to crossflow and water recirculation effects detected by the tool. Overall, the PLT-HPT-SNL logging tool successfully detected crossflow behind casing and computed zonal allocation production using temperature modelling analysis supported by spectral noise and PLT data and validated by surface production data. It is hope that the study can contribute to the improvement of a field-wide scale reservoir allocation and long-term production strategy in Malay basin.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Malay Basin province is a tertiary oil and gas province composed of a complex of half grabens that were filled by lacustrine shales and continental clastic (Michele G., 2002). According to Rosli et al., (2017), complex areas such as Malay basin, interventions using advanced tools for zonal allocation are required but limited application due to operational economics reason. A conventional Production Logging Tool (PLT) is a tool comprises of mechanical spinners that is routinely used to perform a quantitative assessment of each reservoir’s contribution for production allocation. Data from the production logging devices are used to assess fluid production and movement both inside and outside the casing. The production logging devices are small in diameter and are commonly run via tubing to evaluate the well while it is producing to identify sources of undesired fluid phase production, such as water incursions (Jalali et al.,2016). Some of its principal applications include evaluating the success of well treatment or workover operations by comparing before and after job surveys and other applications, and isolating mechanical flaws such as leaking pipes, leaking packers, and fluid movement in cement channels behind pipe. Production logging utilizing traditional sensors like as spinning and density is an efficient and widely used way of documenting fluid movements in boreholes. This method assists oil and gas operators in detecting flow anomalies in the borehole, such as crossflow and downward flow. When a lost returns event is followed by a well control event, crossflow can occur. These sensors, however, cannot detect flows behind the casing since they require direct contact with the fluid to make the measurement. Because the tool is deployed inside the casing, detecting, and measuring crossflow behind the casing is impossible. As a result, production log analysts must presume there is no flow behind the tube.

To address the issue, advanced additions to the conventional production logging tools were introduced i.e. High Precision Temperature (HPT) and Spectral Noise Logging (SNL). According to Zeinalabideen et al., 2021, HPT is a tool that precisely record temperature of liquid in the reservoirs and detect the slightest changes of