

Maximizing Oil Recovery from the Platong Asset: Successful Waterflooding Projects

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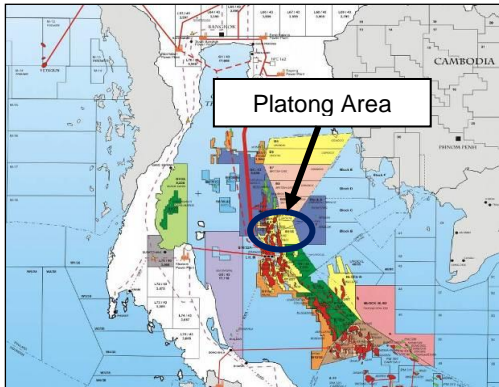


Figure 1: Platong Location Map

Introduction and Innovative Feature

The Platong field is situated in the northern section of the Pattani basin which is composed of both oil and gas reservoirs. A major characteristic of this complexly faulted field is small compartmentalized fluvial reservoirs with depletion drive as the main drive mechanism. Commingling production from multiple reservoirs is required to improve production rate and develop each reservoir at a lower cost.

With small reservoirs and an absence of aquifer support, recovery from primary oil production is low. Aggressive infill programs are required to offset sharp production decline unless secondary recovery methods can be utilized to boost production. The Platong team identified waterflooding as a logical alternative for improving hydrocarbon recovery and sustaining field production.

Realizing that well-to-well sand connectivity would be critical for the success of the project a “common tanks” study was initiated to generate an inventory of oil reservoirs that could be correlated between two or more wells. This also allowed a transition from well management to reservoir management. Our inventory of common oil tanks enabled us to identify wellhead platform within the Plamuk Operating Area as having the greatest waterflood potential. Two platforms that have greatest waterflood potential were Plamuk B and Plamuk E. At the same time, additional effort was made to understand the common gas tanks in order to effectively manage gas resources for gas lifting.

The Plamuk B and Plamuk E multi-disciplinary team proceeded to address the challenges posed by the complex geologic setting and an existing infrastructure developed originally for primary production. This team effort included: a geologist to evaluate well-to-well sand connectivity based on logs, repeat formation tester and production data, a geophysicist to map the structure for each “common tank” and to plan injection wells, a modeler to build 3D models and calculate hydrocarbon volume, a reservoir engineer to run fit-for-purpose simulation models and optimize injector locations, and a production engineer to develop the completion and artificial lift plan.

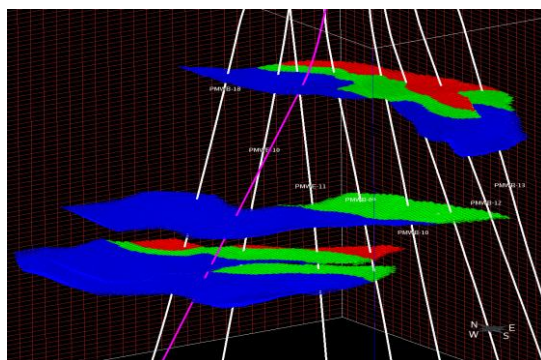


Figure 2 : Platong waterflood development strategy

During the same time, a cross-functional team between petroleum engineers/facility engineers/Operations was formed to evaluate water injection systems using either produced water via a pipeline from the Central Processing Platform (CPP) or a mobile water injection system with sea water injection. The recommendation from the team was to lay a produced water pipeline network from Platong CPP.

As most of the target reservoirs are too small to develop individually, creative well planning was used to design

injectors to penetrate multiple reservoirs. Typically wells are drilled “high and tight” against the fault however the injection wells were angled to penetrate as many “tanks” as possible in a downdip structural position (i.e. pink well path shown in Figure 1 which penetrates the water leg of three tanks).

Multiple perforations from commingled sands pose a significant cross-flow risk when waterflooding wells initially designed for conventional primary production. A team of petroleum engineers and completion engineers came up with detailed completion plans and rigorous well preparation programs that aim to minimize cross-flow risk and enable gas lift capability.

Thai E&P Industry Impact and Value

This collective effort resulted in a final investment decision to lay a water pipeline from the CPP and to drill five injectors in the Plamuk B and Plamuk E areas at the end of 2010, this being the first phase of the Platong waterflood project. During the execution phase of the waterflood project, additional activities included well preparation and stimulation, construction at the CPP, laying of the water pipeline and platform preparation for rig arrival. The cross functional team developed an integrated execution schedule to ensure there would be no conflicts between all the above parties and to maximize the amount of work performed on both platforms.

First injection occurred on the Plamuk E platform in February 2011 and on the Plamuk B platform in April 2011. Waterflood response was observed 2 weeks to 6 months after water injection. Incremental recovery from waterflood over primary depletion is expected to double primary recovery. To date, although some tanks are still in the fill-up period, significant incremental production has been observed with a current incremental production rate almost 80% of total PMWB/E production (see Figure2). The team expects to see continuing improvement from these two platforms.

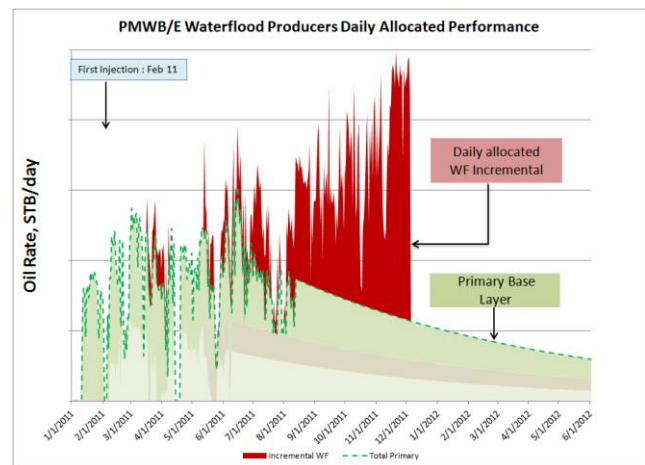


Figure 3 : New production from waterflood

The Plamuk B and Plamuk E waterflood project provides foundational infrastructure for expansion of the waterflood network across the Plamuk area. Water pipelines laid in Q2 2011 allow for Phase 2 development to take place at the Plamuk G, Plamuk H and Plamuk K platforms. As these platforms are identified as gas deficient platforms, investment was also made to install a gas supply trunk line from the CPP to each platform ensuring sufficient and reliable gas for gas lift. The gas supply line is not only essential for future waterflood producers but also for revitalizing oil production from existing wells that stopped flowing due to insufficient gas. The first injection occurred in Q3 2011 at Plamuk G and will be followed by injection at Plamuk H and Plamuk K in 2012 to increase production rates and enhance oil recovery from these platforms.

Why this project should win the award?

Platong is a mature field with a rapid decline rate. The opportunity to revive field production is typically through new infill programs. Initial development lacked a reservoir management aspect; artificial lift plans were not considered and the “well management” strategy resulted in low recovery. Based on success of waterflood programs in adjacent fields, the Platong Team embarked on an asset-wide reservoir characterization project to identify “shared” pay, and assess application of waterflooding to improve recovery.

Challenges include highly complex geology plus uncertainty in volumes and sand connectivity, existing wells with small wellbores, highly perforated and commingled zones of oil and gas, different degrees of pressure depletion and the need for reliable artificial lift system.

To make waterflood work in fluvial point bar deposits complicated by complex faulting an innovative solution was deployed. A multi-disciplinary team worked together to identify reservoirs that would benefit from waterflood and assess incremental reserves. Fit for purpose multi-layer reservoir simulation studies were performed to optimize injector well trajectory through multiple waterflood targets. A team of petroleum engineers/earth scientist/facility engineer/drilling and completion and operations worked collaboratively to mature sensible waterflood development plans, develop a practical well completion plan in existing wells that would be served as waterflood producers or injectors, build an integrated execution schedule and execute the project with zero safety incidents.

Waterflooding, as a secondary recovery method, is expected to double the estimated primary recovery. Significant incremental waterflood rate over primary decline can be observed from the current Plamuk B and Plamuk E waterflood. Currently, waterflood is contributing almost 80% of total Plamuk B&E production and gradually increasing with time.

Implementation of waterflood project will have a major impact on the future of the Platong field and Chevron Thailand. This step-change in production not only creates an appreciation for adopting a reservoir management approach rather than a well management approach but also encourages the team to evaluate other secondary recovery methods that are not traditionally used in small, faulted reservoirs. This type of innovation is a key factor in sustaining Platong field production.