Waskada Unit No. 13

Waterflood Progress Report

January 1st – December 31st, 2013

PennWest

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Table of Contents:

Introduction

Unit Information and Geology

Discussion

Production Performance
Voidage Replacement Ratio
Pressure Surveys
Corrosion and Scale Prevention

Summary and Recommendationas

Attachments

1 Area Map.
2 A spreadsheet of the Unit Well List and History.
3 A Production and Injection plot of the Unit.
4 A spreadsheet of Unit Annual Volumes and Rates.
5 A Cumulative Production and Injection plot of the Unit.
6 A Unit Voidage Replacement Ratio Plot.
7 Individual Injection Well Performance Plots.

Introduction:

The Waskada Unit No.13 pressure maintenance project commenced water injection into the Lower Amaranth designed and in accordance with Manitoba Energy and Mines Approval No. PM 58.

Please refer to Attachment 1 – Area Map.

PRESSURE MAINTENANCE: Governed by Board Order No. PM 58

Unit Information

UNITIZED ZONE: Lower Amaranth
Original Unit, November 1, 1985 Board Order - Voluntary

POOL: Waskada Lower Amaranth A (03 29A)

This report documents the performance of the Waskada Unit No.13 pressure maintenance project for the period of January 1 to December 31, 2013. The Unit had no production or injection in 2013.

Unit # 13 is part of the main Waskada field. The Waskada field is situated on the northeast rim of the Williston Basin in southern Manitoba. It comprises a large portion of Township 1 and 2, Ranges 25 and 26 W1.

Geology

The Waskada Fields produce light density crude (approximately 36^{o} API), predominantly from the Lower Amaranth formation. This is an interlaminated, shallow marine to subtidal succession of sandstones, siltones, and shale progressively onlaps the Mississippian unconformity surface from basin center, up dip to the north and eastern basin limits in Saskatchewan and Manitoba. The fine grained reservoir rock has a complex reservoir characterization with 13 to 16 % porosity and permeability on the order of 0.5 to15 md. The Lower Amaranth, the oldest Mesozoic unit, is a clastic red bed sequence lying directly on the Paleozoic erosional surface. It consists of a series of dolomitic siltstones and sandstones interbedded with argillaceous siltstones and shales. The section is usually subdivided into a lower sandy unit and an overlying shale unit. The lower sequence is the oil production zone. The bulk of pay is found in the laminated sandstone/siltstone facies.

The Lower Amaranth has been classified into four general lithological types:

1. Interbedded shale/siltstone/sandstone by grain size, color and texture
2. Siltstone – This lithology occurs in distinct intervals up to two or three metres in thickness. It is generally light green in color and dolomitic.
3. Laminated sandstone – This occurs in distinct sandy intervals with a wide range of grain sizes and primary sedimentary structures.
4. Massive sandstone – This lithology occurs in thin intervals and usually associated with the laminated sandstones facies. Beds are usually light grey to reddish grey in color and coarse to medium – grained.

Discussion

Production and Injection Performance

Board Order No. PM 58 provided for pressure maintenance operations in Waskada Unit No.13. From the startup of injection in late 1988, injection rates fluctuated to the same degree in each injector, making it difficult to link any production responses to any injector.The Unit includes 5 injection wells, none are currently active, and 13 active producers. Pressure maintenance by water injection ceased in September 2001.

Please refer to Attachment 2 – A spreadsheet of the Unit Well List and History.
Please refer to Attachment 3 – A Production and Injection plot of the Unit.
Please refer to Attachment 4 – A spreadsheet of Unit Annual Volumes and Rates.
Please refer to Attachment 5 – A Cumulative Production and Injection plotof the Unit.

Voidage Replacement Ratio Calculation:

The Cumulative VRR from production start reached a maximum of 1.26 in 1989 and has declined in the last 3 years to 0.4. The Cumulative VRR from injection start stabilized at 2.0 dropping slowly until the last 3 years where it has declined to 0.5. The decline in both Cumulative VRR's in the last 3 years is coincident with no injection from September 2001 and low production and the startup of horizontal producers in 2011. Currently there are no active injector in this Unit and PennWest has no plans to reactivate at this time any of the old injecters.

Please refer to Attachment 6 – A Unit Voidage Replacement Ratio Plot.
Please refer to Attachment 7 – Individual Injection Well Performance Plots.

Pressure Surveys:

No pressure surveys were conducted in 2013.

Corrosion and Scale Prevention Program:

We currently inject ScalCor down all the new horizontal wells. PennWest will be installing cathodic protection on the wells. The new gathering system is Fibreglass and as such is not susceptible to corrosion.

Summary and Recommendations

The behaviour of Waskada Unit 13 producers are indicated by good initial oil productivity, rapidly declining to low decline rates, with almost no discernible water flood response. It is also believed that fracture stimulation treatments, performed on these wells prior to initiation of water injection, "broke through" into the higher productivity Mississippian and that the majority of injected water to date has entered this zone. This is one of the major explanations for lack of waterflood response to date and the continued decline in oil productivities.

A horizontal producer and conversion of vertical producers to injector well pilot was contemplated for the Lower Amaranth targeting Unit 13 with results scalable to all Lower Amaranth Units. The goal being to increase sweep efficiency and ultimately increase the recoverable oil in place. The pilot started late 2012 but because of some technical issues and cold weather the operation was suspended. Alternative injection schemes are being investigated.