[PS] Production Performance of Gas Reservoirs under Bottom Water Drive Mechanisms: A Case Study of Vietnamese Nam Con Son Field Development Project*

T.V. Tran[1], T. Manapov[2], T.H. Nguyen[2], T. Doan[3], and H.M.D. Nguyen[3]

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[1]Bien Dong POC, Ho Chi Minh City, Vietnam (tungtv@biendongpoc.vn)
[2]Rosneft, Ho Chi Minh City, Vietnam
[3]EastSea Star Software Co., Ltd., Ho Chi Minh City, Vietnam

Abstract

Water production tends to kill gas wells and leaves significant amount of gas in the reservoir. This study addresses water drive mechanisms and its effects on production performance of gas reservoirs. The approach focuses on the use of an analysis and a construction of radial numerical models to physically describe the water coning and breakthrough phenomenon and to better understand the impact of an aquifer on deliverability and ultimate recovery of a gas reservoir. Analytical solution obtained from steady state equation shows that water-gas ratio does not increase rapidly until 90% of perforation interval flooded with water. The results show that for a better reservoir quality (permeability >100 mD), withdrawal rates do not have significant impact on reservoir gas ultimate recoveries. High gas production rate helps reduce total water production (water treatment cost savings). Aquifer size has no impact on water breakthrough time but has an impact on recovery factor and total water production. This study also suggests perforating an interval sufficiently long to maximize production.

Production Performance of Gas Reservoirs under Bottom Water Drive Mechanisms: A Case Study of Vietnamese Nam Con Son Field Development Project

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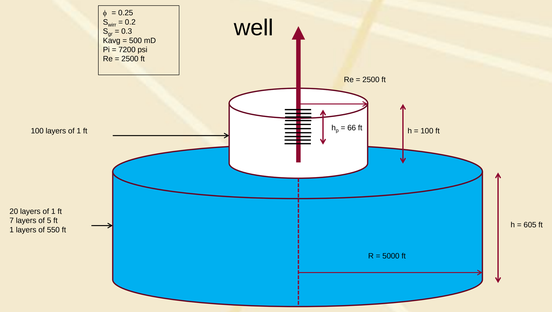
ABSTRACT

Water production tends to kill gas wells and leaves significant amount of gas in the reservoir. This study addresses water drive mechanisms and its effects on production performance of gas reservoirs. The approach focuses on the use of an analytical analysis and a construction of radial numerical models to physically describe the water coning and breakthrough phenomenon and to better understand the impact of aquifer on deliverability and ultimate recovery of a gas reservoir.

The full field model is also built and benchmarks with the radial model to optimize the production scheme for the field development.



Radial Numerical model setup:

- High resolution of vertical layers at GWC
- Exponentially distributed radii
- Liquid loading rate ~ 2.0 mmscf/d
- Max. water production constrain = 5,000 stb/d

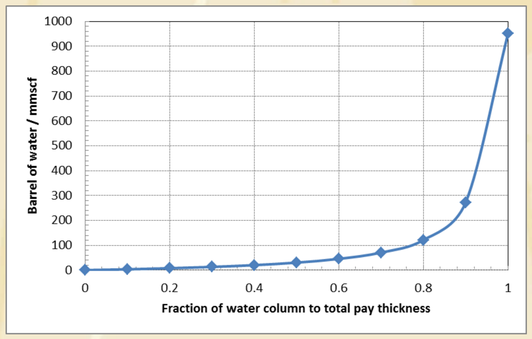
Base case production scheme:

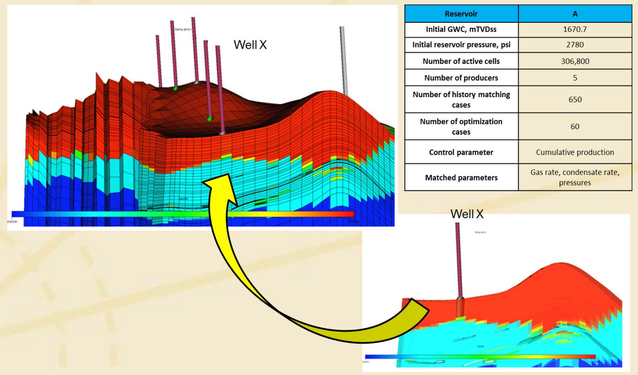
- M = Pore Aquifer Vol. / Pore Gas Vol. ~ 24
- GIIP ~ 118 BCF
- Qg = 40mmscf/d
- Perforated interval = 2/3 total net pay

METHODOLOGY

The analytical analysis of bottom water-drive gas reservoir are performed to evaluate the impact of water break-through on ultimate hydrocarbon recovery.

Analytical solution obtained from steady-state equation shows that water-gas ratio doesn't increase rapidly until 90% of perforation interval flooded with water.



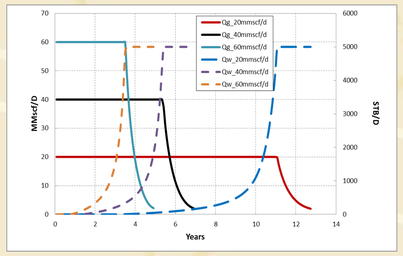


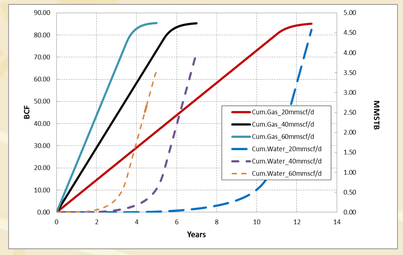
Reservoir	A
Initial GWC, mTVDss	1670.7
Initial reservoir pressure, psi	2780
Number of active cells	306,800
Number of producers	5
Number of history matching cases	650
Number of optimization cases	60
Control parameter	Cumulative production
Matched parameters	Gas rate, condensate rate, pressures

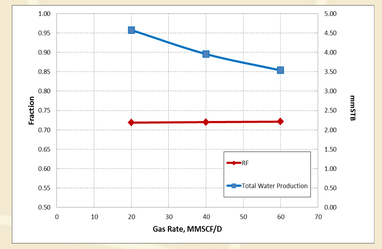
Full-field Numerical model:

- The full field dynamic model are benchmarked with the radial model
- Factors that have impacts on gas ultimate recovery such as withdrawal rate, aquifer size, formation permeability, vertical-to-horizontal permeability are investigated.
- Sensitivity analysis of water-breakthrough and total produced water volume are also studied under various aquifer size and formation reservoir properties.

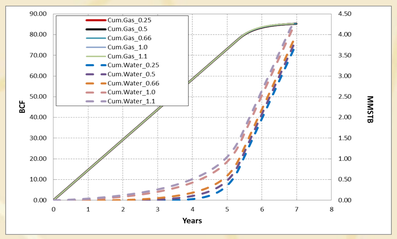
RESULTS

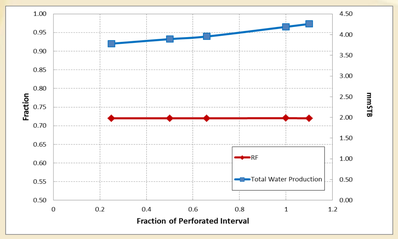




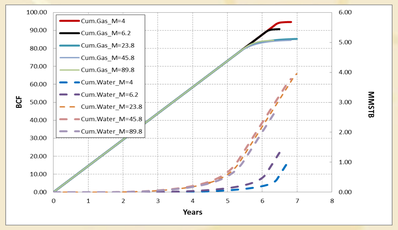


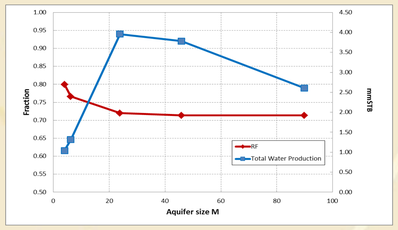
- Recovery factor is not influenced by withdrawal rates
- Increase of production rate results in decrease of total cumulative water production



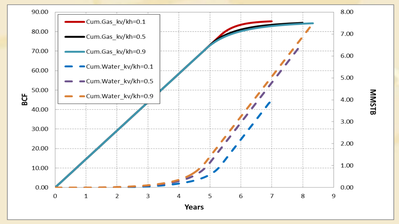


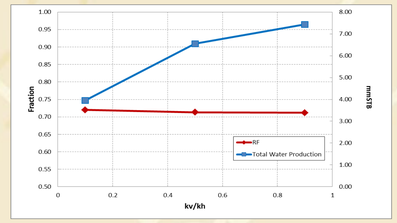
- Weak aquifer support results in higher recovery
- High total water production observed in aquifer size M = 20-50





- kv/kh doesn't have significant impact on gas ultimate recovery
- Higher kv/kh results in higher total cumulative water production





- Ultimate gas recovery is not significant impacted with increased perforated interval
- Perforations closer to GWC can results in the higher total water production

CONCLUSIONS

The results show that for a better reservoir quality (permeability >100 mD), withdrawal rates do not have significant impact on reservoir gas ultimate recoveries. However, high gas production rates helps reduce total water production thus reduce water treatment costs. The aquifer size does not have significant impact on water breakthrough time, but it shows impact on ultimate gas recovery factor and the total water production. It is also concludes that vertical-to-horizontal permeability has no impact on ultimate gas recovery factor but it has impact on total water production.

AAPG Asia Pacific Region

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