Fluid Production from Tight-Gas Systems, Greater Green River and Wind River Basins, Wyoming

Philip H. Nelson

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1U.S. Geological Survey, Denver, CO

Abstract

Gas and water production records provide a basis for examining the differences among tight gas reservoirs. For this purpose, wells with production records spanning at least seven years are selected for each formation in a field. To reduce well interference effects, wells with the earliest production from a field are preferred. Instead of using decline curve analysis, average daily rates of fluid production are computed twice, once after two years of initial production and again five years later; the two averages are then plotted on log-log plots of water vs. gas. The two production points form a vector that shows whether production is increasing or decreasing with time and whether the change in water production is tracking the change in gas production. Also, the water-gas ratio is apparent and can be compared with the expected amount of water condensed from gas for that reservoir. Thus, for all available wells in each field, the plots show production rate magnitudes, water-gas ratios, and production trends over a five-year time span.

Examples from the Greater Green River and Wind River basins in Wyoming illustrate the variability in gas and water production rates from different geological settings. Of all reservoirs studied, Jonah field shows the least well-to-well variation in water and gas production rates. The Pinedale field displays the most uniform declines in water and gas production rates. Production from the upper part of the Almond Formation shows the slowest decline rates. Production within fields in the Wind River basin is more variable than from the Greater Green River basin; for example, water production rates and water-gas ratios vary by a factor of ten or more among wells in the Madden field. Geological factors such as depositional setting and degree of fracturing appear to be responsible for the variation among fields.

Reference

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Philip H. Nelson
U.S. Geological Survey
Goals –

Examine gas, water, oil produced from a tight gas reservoir when first drilled.

Compare production rates, fluid ratios, variability (scatter), and production decline – within a reservoir and among reservoirs within a basin, and among reservoirs in different basins.
**Change in Gas Production**

- Initial: 537 mscf/day
- Initial + 5 years: 191 mscf/day

**Change in Water Production**
- Initial: 91 bbl/day
- Initial + 5 years: 20 bbl/day

** 그래프 설명**

- Y축: 가스 (mcf/day), 물 (bbl/day), 기름 (bbl/day)

- 초기 상태 (initial)
- 5년 후 (initial + 5 years)

**도표 설명**

- 가스 생산률 (mscf/day)
- 물 생산률 (bbl/day)
- 기름 생산률 (bbl/day)

- 초기 상태의 가스 생산률: 537 mscf/day
- 초기 상태의 물 생산률: 91 bbl/day
- 초기 상태의 기름 생산률: 20 bbl/day

- 5년 후 상태의 가스 생산률: 191 mscf/day
- 5년 후 상태의 물 생산률: 20 bbl/day
- 5년 후 상태의 기름 생산률: 537 mscf/day

**수치 표시**

- 가스 (mcf/day)
  - 101
  - 102
  - 103
  - 104

- 물 (bbl/day)
  - 100
  - 101
  - 102
  - 103

- 기름 (bbl/day)
  - 100
  - 101
  - 102
  - 103

**수치 표시**

- 기름 생산률: 10 bbl/MMCF
- 물 생산률: 1/10

- 5년 후 상태의 가스 생산률
  - 20 bbl/day
  - 537 mscf/day
  - 191 mscf/day

- 5년 후 상태의 물 생산률
  - 91 bbl/day
  - 20 bbl/day
No water production:

Pinedale Field
Lance & Mesaverde Formations

Gas Production Rate (mcf/day)

Water Production Rate (bbl/day)

$\log_{10}$ scale

- $10^{-1}$ to $10^4$
- $100$ to $10^4$
- $1000$ to $10^4$
- $10,000$ bbl/MMCF
Relative change in gas and water production over five years time

Pinedale Field
Lance & Mesaverde Formations

Jonah Field
Lance Formation
Greater Wamsutter Area

- West Central
- Central
- East Central
- Southeast
- Northwest

Key:
- Combined
- Upper Almond
- Main Almond

Gas Production Rate (mscf/day) vs. Water Production Rate (bbl/day)
Greater Wamsutter Area

**Upper Almond**

- Gas Production Rate (mcf/day)
- Water Production Rate (bbl/day)

**Main Almond**

**Combined Almond**

- Change in Gas Production
- Change in Water Production

- Greater Wamsutter Area
Six fields in the Wind River Basin

- **Cooper Reservoir - Lower Fort Union**
- **Cave Gulch - Lance**
- **Madden - Lower Fort Union**
- **Madden - Mesaverde**
- **Madden - Cody Shale**

The graphs show the relationship between gas production rate (mscf/day) and water production rate (bbl/day) for each field.
Gas Production Rate (mcf/day)
Water Production Rate (bbl/day)

Greater Green River Basin

Main Almond
Upper Almond
Jonah

No water production:

10 bbl/mmscf
1000
100
10,000

10^1
10^2
10^3
10^4

10^0
10^{-1}

10^{-2}
10^{-3}
10^{-4}

10^1 10^2 10^3 10^4 10^5 10^6
Some fields have very erratic water/gas ratios.

Water production commences with gas production.

Only a fraction of records show water increasing with time.

Most, but not all, wells have water/gas ratios greater than could be dissolved in gas at reservoir P and T.
This talk has illustrated our methods for obtaining and displaying a produced fluids data set for tight gas systems. We plan to continue to add examples to the data set. The data can then be merged with geological parameters to better understand the genesis and evolution of tight gas accumulations.