- Original Paper
- Published: 22 March 2021

Optimizing productivity in oil rims: simulation studies on water and gas injection patterns

- Olabode Oluwasanmi,
- Alonge-Niyi Pastor,
- Onuh Charles,
- Nwozor Christopher &
- Orisamika Seyi

Arabian Journal of Geosciences **volume 14**, Article number: 579 (2021) Cite this article

Abstract

Thin oil rim are reservoirs with hydrocarbon pay zone not more than 100 ft. Production challenges mainly water, and gas coning arises due to this trait and presence of a larger gas cap and aquifer. To safely exploit from oil rim reservoirs, the right production choices and optimization of production parameters need to be implemented before the commencement of any recovery scheme. A case study reservoir of an oil rim in the Niger-delta producing region is placed on a concurrent production via 8 horizontal producer wells after history matching and optimization of production parameters using a black oil simulator (Eclipse). Six different pattern scenarios of water and gas injection at 3 rates are considered: optimized oil recovery estimates of 5.43%, 4.51%, 5.41%, 4.93%, 5.89%, and 5.82% for inverted direct line water injection, inverted staggered water injection, inverted 4 spot injection, 5 spot water injection, inverted 7 spot water

injection, and inverted 9 spot water injection respectively. The incremental oil recovery over the base case (no injection) recorded in like manner are 1.43%, 0.51%, 1.41%, 0.93%, 1.89%, and 1.82%. The results show that pattern water injection at 1000 stb/day is more suitable for optimum oil recovery for oil rims under concurrent production.

Abbreviations

FOE:
oil recovery factor

5SW:
5 spot water injection

7SW:
7 spot water injection

FOPT:
field oil production total

5SG:
5 spot gas injection

7SG:
7 spot gas injection

FGPT:

field gas production total

I5W:
inverted 5 spot water injection

I7W:
inverted 7 spot water injection

WOPT:
well oil production total

I5G:
inverted 5 spot gas injection

I7G:
inverted 7 spot gas injection

SWL:
staggered water injection

4SW:
4 spot water injection

9SW:
9 Spot Water Injection

ISW:
inverted staggered water injection

4SG:
4 spot gas injection

9SG:
9 spot gas injection

DLW:
direct line water injection

I4W:
inverted 4 spot water injection

I9G:
inverted 9 spot water injection

IDW:
inverted direct line water injection

I4G:
inverted 4 spot gas injection

I9W:
inverted 9 spot water injection

ISG:
inverted staggered gas injection

SGL:
staggered gas injection

References

- Akpabio JU, Akpanika OI, Isemin IA (2013) Horizontal well performance in thin oil rim reservoirs. Int J Eng Sci Res Technol, ISSN: 2277-9655, 2 (2)
- Ezzem AR, Keng SC, Nasir D (2010). Breaking oil recovery limit in Malaysian thin oil rim reservoirs: enhanced oil recovery by gas and water injection. Enhanced Oil Recovery Conference. Kuala Lumpur. SPE-143736-MS.
- Haug, B. T., Ferguson, W. I., Kydland, T., and Hydro, N. (1991). Horizontal wells in water zone: most effective way of trapping oil from thin oil zones. Annual Technical Conference and Exhibition. Dallas. SPE 22929.
- Kolbikov, S. Peculiarities Oil Rim Development (2012), SPE Russian oil and gas exploration and production technical conference and exhibition, SPE (160678) 16-18 October, Moscow, Russia.

- Masoudi R (2013). How to get the most out of your oil rim reservoirs? Reserv Management and Hydrocarbon Recovery Enhancement Initiatives. SPE-16740-MS.

- Njar, N. N. (2018). Optimizing well placement using genetic algorithm and simulated annealing: a comparative analysis. Ogun State, Nigeria. Department of Petroleum Engineering, Covenant University.

- Ogbeiwi P, Yetunde A, Dickson U (2017) An approach to water flood Optimization of reservoir X. J Pet Explor Prod Technol 8:271–289

  Article **Google Scholar**

- Olabode OA (2020) Effect of water and gas injection schemes on synthetic oil rim models. J Pet Explor Prod Technol. https://doi.org/10.1007/s13202-020-00850-3
- Olabode OA, Egeonu GI (2017) Effect of horizontal well length variation on productivity of gas condensate well, 9271. Int J Appl Eng Res ISSN 0973-4562 12(20):–9284

- Olabode O, Egeonu G, Ojo T, Bamigboye O (2018a) Predicting the effect of well trajectory and production rates on concurrent oil and gas recovery from thin oil rims. IOP Conf Ser Mater Sci Eng 413(1):012051

  Article **Google Scholar**

- Olabode OA, Egeonu G, Ojo T, Oguntade O, Bamigboye O (2018b) Production forecast for Niger Delta oil rim synthetic reservoirs. Data Brief 19:2205–2214

  Article **Google Scholar**

- Olabode OA, Orodu OD, Isehunwa S, Mamudu A, Rotimi T (2018c) Effect of foam and WAG (water alternating gas) injection on performance of thin oil rim reservoirs. J Pet Sci Eng 171:1443–1454

  Article **Google Scholar**

- Olabode O, Etim E, Emeka O, Tope O, Victoria A, Charles O (2019) Predicting post breakthrough performance of water and gas coning. Int J Mech Eng Technol 10(2)
- Olabode OA, Ojo T, Oguntade T, Oduwole D (2020a) Recovery potential of biopolymer (B-P) formulation from Solanum tuberosum (waste) starch for enhancing recovery from oil reservoirs. Energy Rep 6. https://doi.org/10.1016/j.egyr.2020.05.027
- Oluwasanmi Olabode, David Alaigba, Daniel Oramabo, Oreofeoluwa Bamigboye (2020b). Modelling low salinity water flooding as a tertiary oil recovery technique, J Model Simul Eng, https://doi.org/10.1155/2019/6485826, Article ID-6485826.
- Olabode O. A.,Ogbebor V. O., Onyeka E. O., Felix B. C. (2020c). The effect of chemically enhanced oil recovery on thin oil rim reservoirs. J Petrol Explor Prod Technol. DOI: https://doi.org/10.1007/s13202-021-01090-9.
- Onyeukwu I, Peacock A, Matemilola S, Igiehon O (2012). Improving oil recovery from oil rim reservoirs by simultaneous gas and water injection. Nigerian Annual International Conference and Exhibition. Abuja. SPE-162956-MS.
- Schlumberger. (2020). *Injection Pattern*. Retrieved from Oil field glossary: www.glosary.oilfiled.slb.com/en/Terms/i/injection_pattern.aspx.
- Thang, B., James, F., Raj, D., Carigali, S., Richard, H., and Mohamed, A. (2010). Improving oil recovery from thin oil rim by simultaneous downdip gas and up dip water injection- Samarang Field, Offshore Malaysia, EOR Conference at Oil and Gas West Asia. Muscat. SPE 128392.
- Wafaa AG, Ridha G, Meshal A (2009). Designing a simultaneous water alternating gas process for optimizing oil recovery. Annual Conference and Exhibition. Amsterdam. SPE- 120375-MS

Author information

Authors and Affiliations

1. **Department of Petroleum Engineering, Covenant University, Ota, Ogun State, Nigeria**
Olabode Oluwasanmi, Alonge-Niyi Pastor, Onuh Charles & Nwozor Christopher

2. **Department of Petroleum Engineering, University of Ibadan, Ibadan, Oyo State, Nigeria**

Orisamika Seyi

Corresponding author

Correspondence to Olabode Oluwasanmi.

Ethics declarations

Conflict of interest

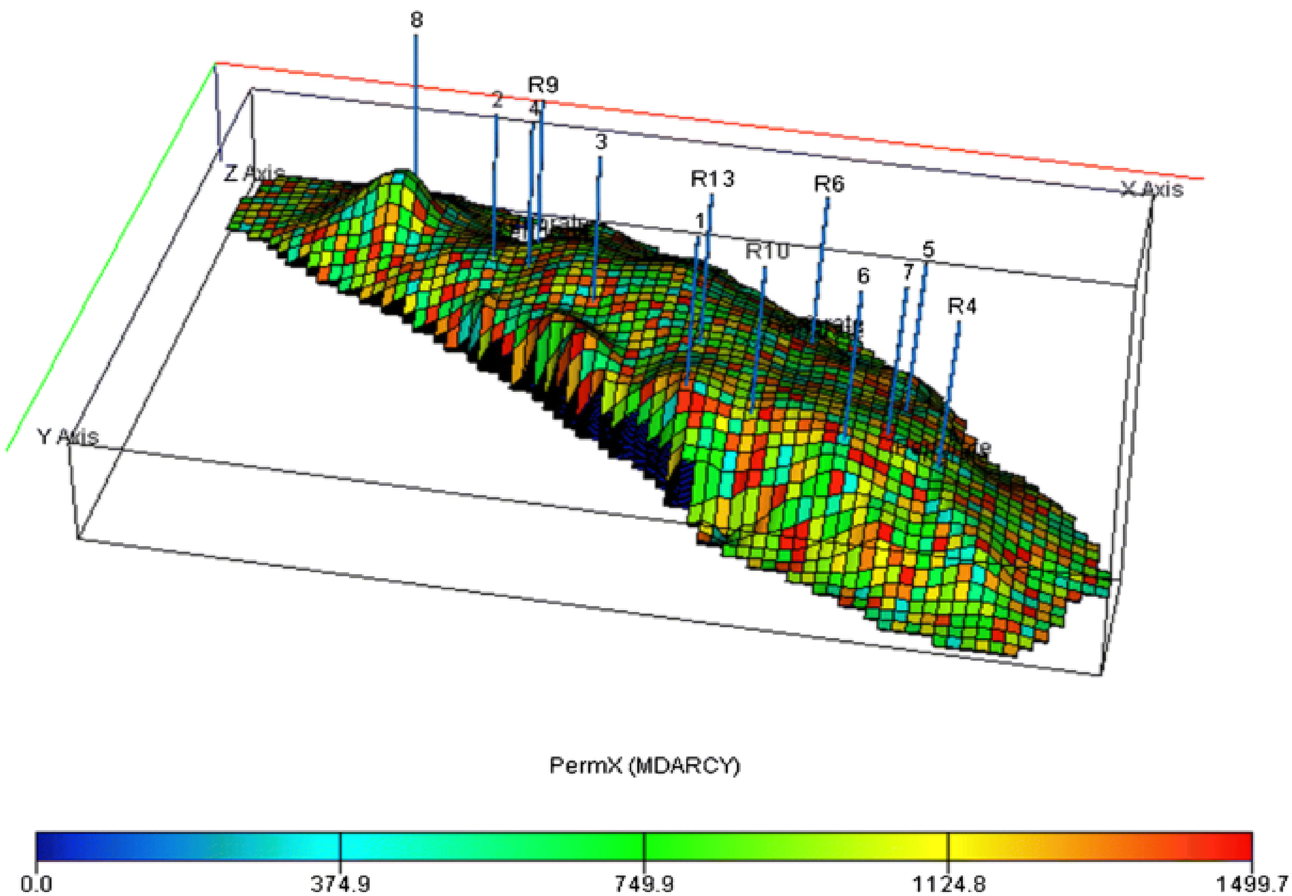
The authors declare that there is no conflict of interest in the development of this article.

Additional information

Responsible Editor: Murat Karakus

Appendix

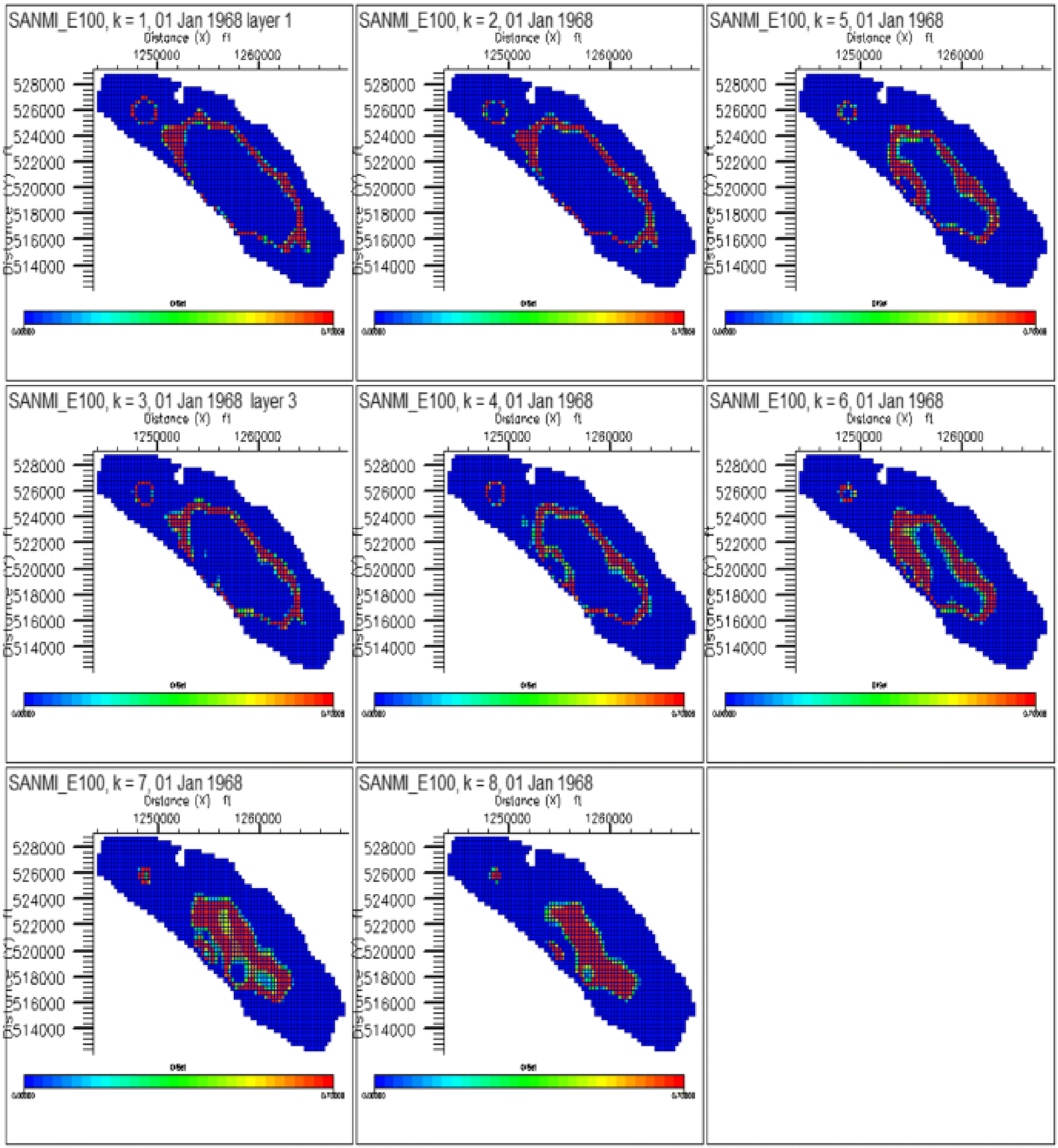
Fig. 10



Locations of 8 prediction wells on a permeability scale

Full size image

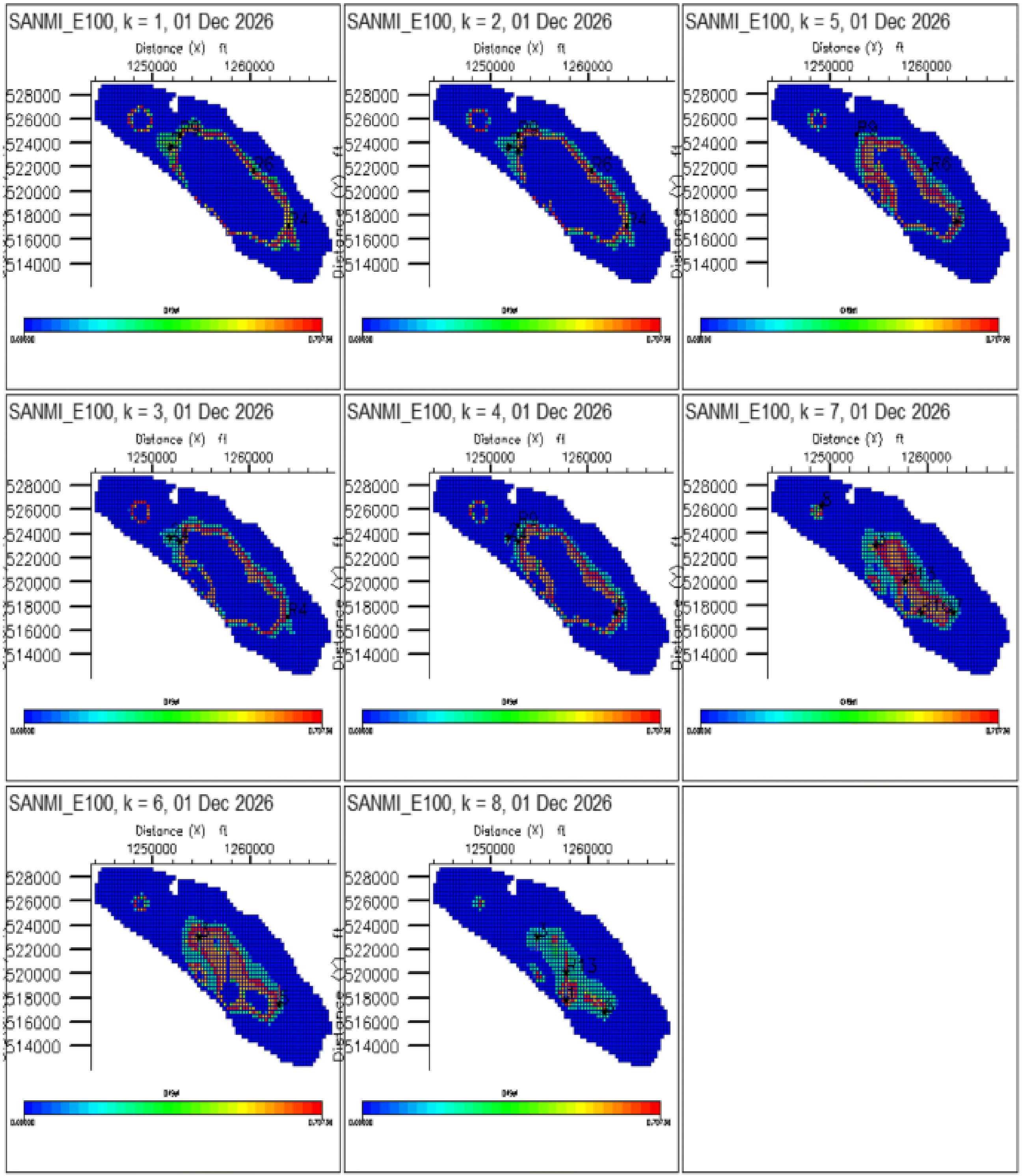
Fig. 11



Initial oil saturation (before 8 producer wells)

Full size image

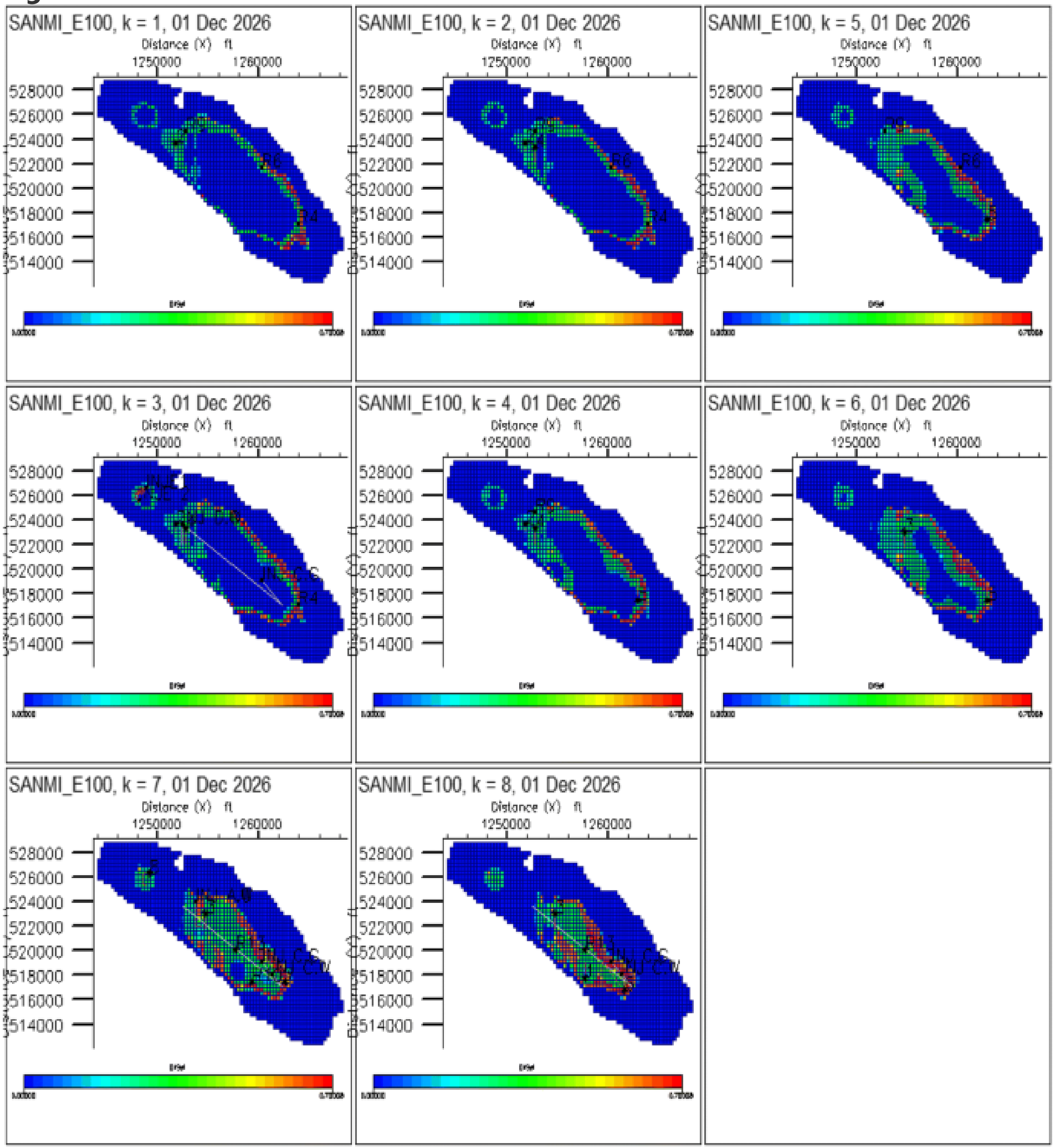
Fig. 12



Final oil saturation (after initializing 8 producer wells)

Full size image

Fig. 13



Final oil saturation (after inverted 7 spot water injection at 1000 stb/day)

Full size image

Rights and permissions

About this article

Cite this article

Oluwasanmi, O., Pastor, AN., Charles, O. *et al.* Optimizing productivity in oil rims: simulation studies on water and gas injection patterns. *Arab J Geosci* **14**, 579 (2021). https://doi.org/10.1007/s12517-021-06945-3

Download citation

- Received25 September 2020
- Accepted11 March 2021
- Published22 March 2021
- DOIhttps://doi.org/10.1007/s12517-021-06945-3

Keywords

- **Thin oil rim**
- **Concurrent production**
- **Water injection**
- **Gas injection**
- **Injection pattern**