The Kern River Reservoir of the Kern River Field: A Closed System*

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Abstract

This study expands on the work of Coburn and Gillespie (2002), whose results suggest that a water management program to remove of excess water from the producing zones will increase steamflood efficiency. The current management plan bolsters the inward pressure gradient allowing fluids to be more efficiently produced and ensuring they remain in the bounds of the oil field. The previous work is limited to an updip section of the Field near the Kern River. To understand if the closed system assumption holds true for deeper western areas where there may be questions over the hydraulic connection to the SJ Basin or and Upper Chanac Formation below, a similar study was performed. There a correlation was found between increased production from interdiction wells and oil production and it is likely a result of a more efficient steam chest. Two causes for increased oil production may include greater accommodation space for the steam chest to expand caused by the reduction of reservoir fluids and/or a lower reservoir pressure required to maintain the steaming operations. Furthermore, in mature fields with a bottom water drive, it is common for the percentage of produced water to increase as oil production decreases with depletion. This is not the case for the Kern River Oil Field as the water-oil ratio has decreased over time. The decreasing water-oil ratio is strong evidence that the region acts as a closed system and maintains the economic viability of the oil field.

References Cited


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https://commons.wikimedia.org/wiki/File:Kern_River_Oil_Field_aerial.jpg
Geologic Applications in a Changing Regulatory Environment

Questions and results of this study were brought about through discussions between the DOGGR and the Water Boards during the aquifer exemption process.

All data for this analysis is publically available on the DOGGR website.
Geologic Applications in a Changing Regulatory Environment

- 16th Largest
- 13,000 active wells
- Producing since 1898
- >2.3 Billion Barrels of Oil Produced
- 247 million barrels of water produced in 2017
- 8-13% Water cut
- Within and surrounding Bakersfield City limits
The Safe Drinking Water Act (SDWA)

- Defaults to protecting all water (unless exempt or >10k mg/L).
- The US EPA is agency that makes the decision for whether an exemption is appropriate.
- The Division follows PRC 3131 (a) that mandates further scrutiny prior to proposing to the EPA.
- My study was borne from the criteria that:
  - The injection of fluids will not affect the quality of water that is, or may reasonably be, used for any beneficial use.
  - The injected fluid will remain in the aquifer or portion of the aquifer that would be exempted.
So, if the injected fluid will remain in the aquifer or portion of the aquifer that would be exempted, is the Kern River Field an open or closed system?

Conventional Wisdom: No

- Kern River flows over outcrop through the field
- Interdiction wells produce high volumes of water from downdip within the field.
- Gravity drainage (largest pumping units to the west and decrease in size as you drive east).
- No study looks at this question the closest (Bauman et al 2002)

(Coburn and Gillespie 2002)
Total water production drops but oil production rises.
Interdiction Pumping begins

Slowed decline and increase in oil production from more efficient steam chest caused by interdiction pumping.
Decreasing Water-Oil Ratio = No water from outside sources
Primary Production

EOR Production

Decreasing water cut from primary production

Steamflood Injection Begins

DOGGR created

EOR Begins

Co-generation plant

Cawelo water

Salvage Perforations

Consistent well count trend

Decreasing water cut trend of Water Cut 1946-1980

Fillup?
Conclusion

• The field acts as an **operationally controlled closed system** as the water from the field is being removed faster than the oil. This fluid is not replaced save for injection to maintain and grow the steam chest.

• The results agree with Coburn and Gillespie who found that produced water is not replaced by natural sources over the time periods required for oilfield operations.

Lastly, I challenge you to go and explore DOGGR’s well finder, with a little digging you may just see that the field wide WOR ratio has been decreasing save for vigorous periods of field dewatering which has been ongoing since ~1996.