Journal of Petroleum Science and Engineering 68 (2009) 223–234

Contents lists available at ScienceDirect

Journal of Petroleum Science and Engineering

journal homepage: www.elsevier.com/locate/petrol

Research paper

Application of prediction models to performance of high paraffinic content oilfields: Case study Shen95 Block of Jinganbao Oilfield

Oyinkepreye David Orodu [a,*], Zhonghua Tang [b], Qi Fei [a]

[a] Faculty of Resources, China University of Geosciences (Wuhan), Wuhan 430074, China
[b] Faculty of Environmental Studies, China University of Geosciences (Wuhan), Wuhan 430074, China

ARTICLE INFO

Article history:
Received 31 July 2007
Accepted 29 June 2009

Keywords:
high-paraffinic oil
production prediction
decline curve analysis
oil-cut decline
water displacement curve
oil recovery

ABSTRACT

Production performance was curve-fitted for prediction of production and estimation of incremental recovery for waterflooded reservoir. Arguably, simulation may yield non-unique solution or fail due to assumptions on the true effect of high-paraffin content on porosity, saturation, and fluid rheology in the entire formation caused by temperature and solubility effects. The curve-fitting models applied are Arps' rate–time models and Li–Horne mechanistic model proven applicable to waterflooded and naturally fractured reservoirs. Others are Corrêa's volumetric oil-cut decline model tested on heterogeneous, waterflooded, high viscous and heavy oil reservoirs characterized by volumetric-exponential decline and a water displacement curve method. The match periods for Arps' models were constrained by criteria from literature reviewed to ensure that decline was relatively under the influence of relative permeability and not operational changes. The models were chosen to match performance primarily of Shen95 Block, a faulted block in the Damintun depression, Liaohe basin, China, characterized by high pour point within 42–64 °C. Recovery estimate was not entirely consistent with past findings of Li–Horne model estimates falling in-between exponential and harmonic decline estimates, but consistent with harmonic decline estimates. Performance match preference was Corrêa's model, but the model was extended to specifically characterize performance trend by reciprocal decline exponent ($\beta=-2$) beyond the prior considered range of ($-1\leq\beta\leq0$). The other block considered, a naturally fractured reservoir having similar fluid properties with Shen95 was also characterized by ($\beta=-2$). A holistic approach will require the alternate use of the models based on the strong points of each model according to theory, performance trends and operational changes.

1. Introduction

Shen95 Block of Jinganbao oilfield, characterized by high pour point black oil (42 °C–64 °C), paraffin content of 37.7%, and 12–20% colloid and asphaltene content is seldom seen in the world. Whereas, the reservoir temperature is just a few degrees above the maximum pour point temperature. These make exploitation difficult and marked by low incremental recovery with regards to the peculiarity of formation damage greater at and around both injection and production wells. Damage is a consequence of paraffin deposition from decline of temperature at production and injection wells due to gas expansion and evolution (Ring et al., 1994) or cold water injection eventually causing low sweep and rapid water encroachment (Bedrikovetsky, 1997). Precipitated paraffin travels a short distance about 0.6096 m (2 ft) (Ring et al., 1994) thereby making damage concentrated at the vicinity of the wells.

Production test started in 1982 and full scale development commenced in late 1988, by late 2005 the block had 111 wells including 50 producing oil and 10 water injection wells on operation having cumulative oil production of 167×10^4 t (11.86 MMbbl), oil recovery of 8.52% based on volumetric method estimate of 1958×10^4 t (139 MMbbl) OOIP, 63% water content, and cumulative voidage replacement ratio of 1.3. The block being on production for about 20 years and also a relatively matured waterflooded reservoir, prediction from different techniques is practicable. Performance matching of history production data, prediction of future performance trends and ultimate reservoir recovery are no mean feat as neither empirical nor analytical techniques can accurately match all production data and conveniently interpret performance trends, even numerical simulation is not left out. Simulation may fail due to uncertainty associated with reservoir characterization (Li and Horne, 2005) or present non-unique solution as a result of unrealistic assumptions or misinterpretation of cause of waterflood failure (Baker, 1997). Likewise decline curve fitting can also yield non-unique solution but performance improves for longer data match and under constant conditions (Nguyen and Chan, 2005). Performance curves are known to inherently reflect reservoir properties, flood pattern,

* Corresponding author. Tel.: +86 13871107932.
E-mail address: preye.d.orodu@gmail.com (O.D. Orodu).

0920-4105/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.petrol.2009.06.022