International Journal on Emerging Technologies 11(5): 638-641(2020)

ISSN No. (Print): 0975-8364
ISSN No. (Online): 2249-3255

Horizontal Well in an Infinite Reservoir with Top Gas Cap

J.O. Oloro[1] *and U.K. Okpeki*[2]
[1]*Senior Lecturer, Department of Chemical and Petroleum Engineering, Delta State University, Delta State, Nigeria.*
[2]*Lecturer, Department of Electrical/Electronic Engineering, Delta State University, Delta State, Nigeria.*

(Corresponding author: J.O. Oloro)
(Received 12 October 2020, Revised 23 November 2020, Accepted 16 December 2020)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The model has been developed to determine the pressure distribution of a horizontal well in an infinite reservoir subjected by a top gas cap at a late period using the source function and Newman product principle. A numerical method was used to compute dimensionless pressure and dimensionless pressure derivative. The pressure distribution is presented in Table 1. The dimensionless pressure decreases with time. In contrast, dimensionless pressure derivative (P_D') increases with time. The production process of producing oil will be concise, and the rate of decline is about 2.70E-05. The Effect of external dimensionless distance along the x-axis on dimensionless pressure is not defined between when tD =0.001 and when tD =1 and when t_D =100 and when t_D =10000. At t_D = 10, P_D increases with the value x_{eD}. Hence at this particular time, the value of x_{eD} can be increase for optimum productivity. The external dimensionless distance along the x-axis does not affect P_D'. Variation of y_{eD} does not bring significant change in P_D and P_D'. Hence, for well completion, a horizontal well can be positioned at any point in the y-axis. The smaller the value of h_D, the higher the value of P_D and P_D'. Hence for highly productive, small h_D is required. Oil recovery from these types of reservoirs is often problematic because coning or the crest of undesirable fluids is inevitable and often leads to low oil recovery rates.

Keywords: Dimensionless, Gas cap, Horizontal well, Late period, Production**.**

Nomenclature:
ywD = Well coordinate in y-direction
yeD = External dimensionless distance along y-axis
∞ = Infinity
xD= Dimensionless distance along the x-axis
xeD = External dimensionless distance along x-axis
yD = Dimensionless distance along the y-axis
zD = Dimensionless distance along the z-axis
zwD =Well coordinate in z-direction
xwD =Well coordinate in x-direction
P'D =Dimensionless Pressure derivative
PD= Dimensionless Pressure
hD= Dimensionless height

I. INTRODUCTION

Horizontal well technology is well-known for enhancing low-permeability reservoirs' well productivity, particularly for reservoirs with bottom water or gas cap [1–6] Ohaegbulam *et al.,* were on the Analysis of Wellbore Pressure Drop on Horizontal Well Performance. Their work on the wellbore pressure drop on horizontal well performance problem and from the result of their work shows that there is an optimal horizontal well length outside which oil production rate will no longer be comparative to horizontal well length [7] Cunliang *et al.,* 2019 work was on the Process of the Water-Flooding Reservoir with Gas Cap, this paper goals to resolve the difficulties that the current method is having [8].

This study aims to develop a model to determine the pressure distribution of a horizontal well in an infinite reservoir subjected by a top gas cap at a late period. The aim is to determine the Effect of external dimensionless distance along the x-axis, the Effect of outer dimensionless distance along the y-axis, and thickness on dimensionless pressure.

II. MATERIALS AND METHODS

Physical Description of the Mathematical Model
Fig. 1 is a physical description of the reservoir with top gas cap and infinite acting well locations xw, yw, and zw in x, y, and z directions.

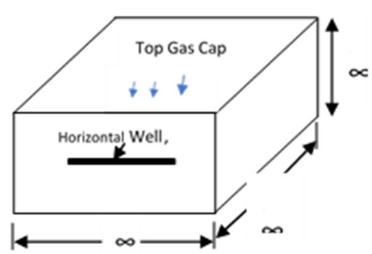

Fig. 1. Reservoir Top Gas Cap and Infinite acting [9].

X-axis: Considering the physical model in Fig. 1, the well experiences an infinite slab source from an infinite slab reservoir. Hence, the appropriate source function is

$$S(x_D,t_D) = \frac{1}{2\sqrt{\pi t_D}} exp\left[-\frac{(x_{wD}-x_D)^2+(y_{wD}-y_D)^2}{4t_D}\right] \quad (1)$$

Y-axis

The well is presumed to have an infinite width along the y-axis. Therefore, an infinite plane source in an infinite slab reservoir early, represented as follows:

$$S(y_D,t_D) = \frac{1}{2\sqrt{\pi t_D}} exp\left[-\frac{(y_{wD}-y_D)^2}{4t_D}\right] \quad (2)$$

Z-axis

The top and bottom boundaries are felt during test time, then along the z-axis, the well experiences an infinite plane source in an infinite slab reservoir, represented as follows

$$S(z_D,t_D) = \frac{2}{h_D}\sum_{n=1}^{\infty} 1+2\exp\left[-\frac{l^2\pi^2 t_D}{{h_D}^2}\right] * \sin\frac{l\pi z_D}{h_D} \sin\frac{l\pi z_{WD}}{h_D} \quad (3)$$

$$P_{D}=2\pi h_D \int_0^{t_D} S(x_D,t_D),S(y_D,t_D),S(z_D,t_D)\,\partial t_D \quad (4)$$

Putting equations 1, 2 and 3 in 4, we have Equation 5 as the pressure distribution for a reservoir with Bottom water and infinite acting.

$$P_D = \frac{1}{2\sqrt{\pi t_D}} exp\left[-\frac{(x_{wD}-x_D)^2+(y_{wD}-y_D)^2}{4t_D}\right] * \frac{1}{2\sqrt{\pi t_D}} exp\left[-\frac{(y_{wD}-y_D)^2}{4t_D}\right] * \frac{2}{h_D}\sum_{n=1}^{\infty} 1+2\exp\left[-\frac{l^2\pi^2 t_D}{{h_D}^2}\right] * \sin\frac{l\pi z_D}{h_D} \sin\frac{l\pi z_{WD}}{h_D} \quad (5)$$

The required dimensionless pressure for the reservoir system is given in Equation 5. Dimensionless pressure derivative is given as

$$p_D' = t_D \frac{\partial p_D}{\partial t_D} \quad (6)$$

Equation 6 can be written as

$$P'_D = \frac{t_D}{2\sqrt{\pi t_D}} exp\left[-\frac{(x_{wD}-x_D)^2+(y_{wD}-y_D)^2}{4t_D}\right] * \frac{1}{2\sqrt{\pi t_D}} exp\left[-\frac{(y_{wD}-y_D)^2}{4t_D}\right] * \frac{2}{h_D}\sum_{n=1}^{\infty} 1+2\exp\left[-\frac{l^2\pi^2 t_D}{{h_D}^2}\right] * \sin\frac{l\pi z_D}{h_D} \sin\frac{l\pi z_{WD}}{h_D} \quad (7)$$

III. RESULTS AND DISCUSSION

The results of a horizontal well in an infinite reservoir supported by Top gas cap are presented in the dimensionless form in Table 1. The dimensionless pressure decrease with time. While dimensionless pressure derivative (PD') increases with time, as shown in Fig. 2. The production process of producing oil will be concise, and the rate of decline is about 2.70E-05.

Table 1: (x_{eD}, y_{eD}, x_D, x_{wD}, y_D, z_{wD}, z_D, h_D :6,2, 0.25, 0.25, 0.74,0.74, 0.55, 0.55, 30).

t_D	P_D	P_D'
0.001	0.03949406	2.70E-08
1.00E-02	4.63E-03	2.70369e-7
0.1	6.70E-04	2.70E-06
1	1.12E-04	2.70E-05
10	5.57E-06	2.70E-04
100	2.95E-07	2.69E-03
1000	1.30E-08	2.65E-02
10000	1.21E-09	2.52E-01

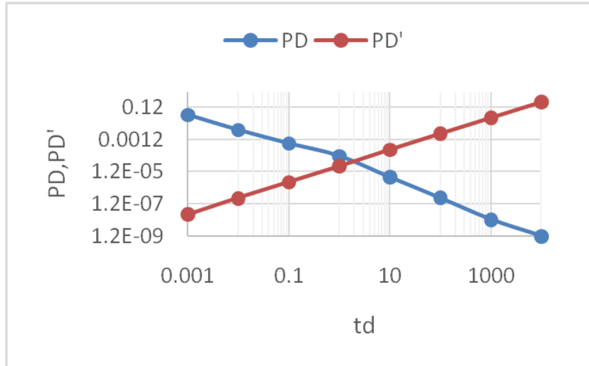

Fig. 2. log-log of $t_D$vs P_D,P_D.

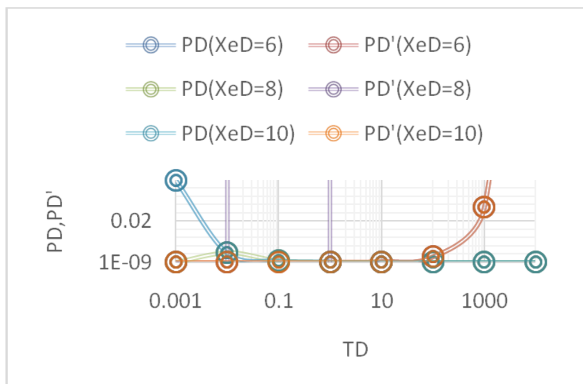

Fig. 3. Effect of external dimensionless distance along x-axis on dimensionless pressure and dimensionless pressure derivative.

To determine the Effect of x_{eD} on P_D and P_D', x_{eD} was varied with the time between 8 and 10 shown in Fig. 3. From Fig. 3, it is noted that the Effect of external dimensionless distance along the x-axis on dimensionless pressure is not defined between when t_D =0.001 and when t_D =1 and also when t_D =100 and when t_D =10000 as shown in Fig. 4. Att_D = 10, P_D increases with the value $x_{eD.}$ Hence at this particular time, the value of x_{eD} can be increase for optimum productivity. Fig. 3 and 5 show that xeD does not affect the PD.

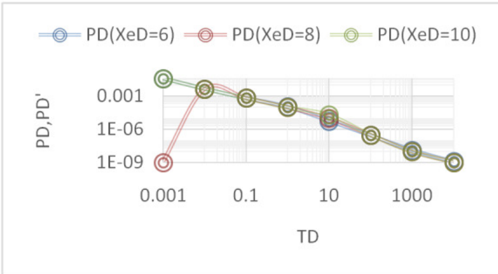

Fig. 4. Effect of external dimensionless distance along with axis on dimensionless pressure derivative.

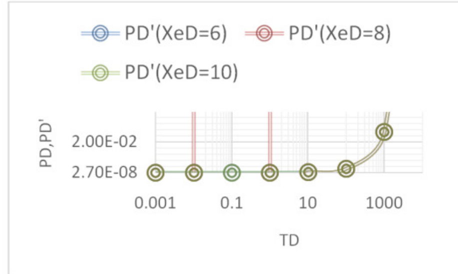

Fig. 5. Effect of outer dimensionless length along x- x-axis on dimensionless pressure.

Table 2: Effect of external dimensionless distance along y-axis on dimensionless pressure and dimensionless pressure derivative.

t_D	$P_D(y_{eD}=4)$	$P_D'(y_{eD}=4)$	$P_D(y_{eD}=6)$	$P_D'(y_{eD}=6)$	$P_D(y_{eD}=2)$	$P_D'(y_{eD}=2)$
0.001	0.0395	2.70E-08	0.03949406	2.70E-08	0.03949406	2.70E-08
1.00E-02	4.60E-03	2.70E-07	4.63E-03	2.70369e-7	4.63E-03	2.70369E-7
0.1	7.00E-04	2.70E-06	6.70E-04	2.70E-06	6.70E-04	2.70E-06
1	1.00E-04	2.70E-05	1.12E-04	2.70E-05	1.12E-04	2.70E-05
10	6.00E-06	2.69E-04	5.57E-06	2.70E-04	5.57E-06	2.70E-04
100	3.00E-07	2.69E-03	2.95E-07	2.69E-03	2.95E-07	2.69E-03
1000	1.00E-08	2.65E-02	1.30E-08	2.65E-02	1.30E-08	2.65E-02
10000	1.00E-09	2.52E-01	1.21E-09	2.52E-01	1.21E-09	2.52E-01

To determine the Effect of external dimensions distance along the y-axis on dimensionless pressure and dimensionless pressure derivative values of yeD (4, 6 and 2) was used as shown above in Table 2. From the Table, the variation of yield does not bring significant change in P_D and P_D'. Hence, for well completion, a horizontal well can be positioned at any point in the y-axis.

Effect of dimensions height on dimensionless pressure and the dimensionless pressure derivative was carried out by varying the value of HD (30, 20 and 10) as shown in Fig. 6. The smaller the value of the head, the higher the value of P_D and P_D'. Hence, for highly productive, small head is required.

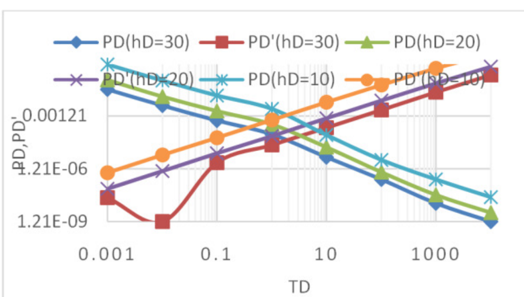

Fig. 6. Effect of dimensionless height on dimensionless pressure and dimensionless pressure derivative.

To determine the Effect of well coordinate in x-direction on dimensionless pressure and dimensionless pressure derivative, the value of x_{wD} was varied (0.25, 0.5 and 1) as shown in Fig. 7. The figure, variation of x_{wD} between t_D =0.001 and when t_D =10 did not P_D as shown in Fig. 8. Also, from the Figure, the longer the $x_{wD,}$ the shorter the time, as shown in Fig. 8. In the PD, a variation of x_{wD} between t_D =0.001 and when t_D =1 did not P_D's shown in Fig. 9, also, from the Figure, the longer the $x_{wD,}$the shorter the time in Fig. 9.

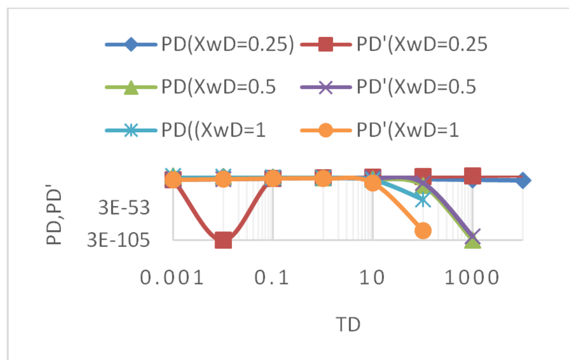

Fig. 7. Effect of well coordinate in x-direction on dimensionless pressure and dimensionless pressure derivative.

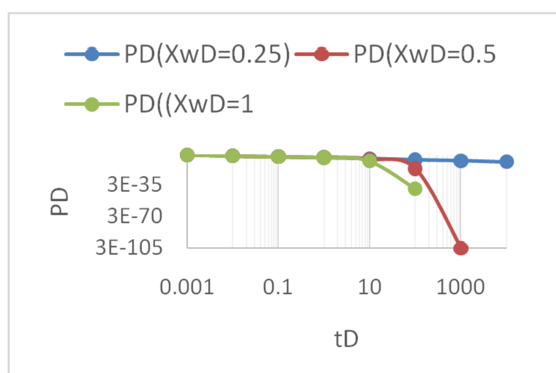

Fig. 8. Effect of well coordinate in x-direction on dimensionless pressure

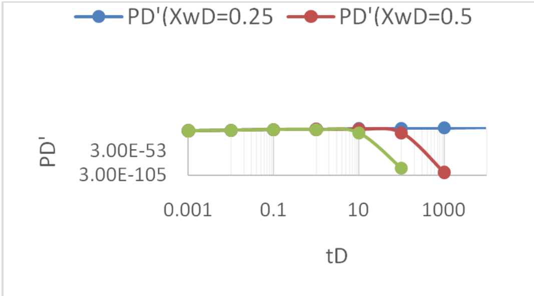

Fig. 9. Effect of well coordinate in x-direction on dimensionless pressure derivatives.

Oil recovery from these types of reservoirs is often problematic because coning or the crest of undesirable fluids is inevitable and often leads to low oil recovery rates [10-12].

IV. CONCLUSION

The model has been developed to determine horizontal well's pressure distribution in an infinite reservoir subjected by a top gas cap at a late period. The following conclusions are drawn:

(i) The production process of producing oil will be concise.

(ii) The rate of decline is about 2.70E-05

(iii) x_{eD} does not have Effect on P_D'

(iv) The longer the x_{wD}, the shorter the time.

Conflict of Interest. The authors have no conflict of interest and have agreed to submit it to your journal house for possible publication.

REFERENCES

[1]. Jianzhong, Q. Shiqing, C. Youwei, H. Dingyi, L., Le, L., Xinzhe, S., & Haiyang, Y. (2018). Diagnosis of Water-Influx Locations of Horizontal Well Subject to Bottom-Water Drive through Well-Testing Analysis, Hindawi Geofluids, 1- 14.

[2]. Hu, J., Zhang, C., Rui, Z., Yu, Y., & Chen, Y. (2017). Fractured Horizontal well productivity prediction in tight oil Reservoirs. *Journal of Petroleum Science and Engineering*, *151*: 159– 168.

[3]. Guo, T, Li, Y., Ding, Y, Qu, Z., Gai, N and Rui, Z. (2017). Evaluation of Acid fracturing treatments in the shale Formation. *Energy & Fuels, 31*(10): 10479-10489.

[4]. Tang, H., Chai, Z., Yan, B., & Killough, J. (2017). Application of multi-segment well modeling to simulate well interference, in *Proceedings of the Unconventional Resources Technology Conference,* Austin, TX, USA: 24-26.

[5]. Qihong, F., Tian, X., Sen, W., & Harpreet, S. (2017). PressureTransient Behaviour of Horizontal Well with Time-Dependent Fracture Conductivity in Tight Oil Reservoirs, *Hindawi Geofluids*: 1-19.

[6]. Ohaegbulam, M. C., Izuwa, N. C., & Onwukwe, S. I. (2017). Analysis of Wellbore Pressure Drop on Horizontal Well Performance. *Oil Gas Res*., *3*(2): 1-7.

[7]. Cunliang, C., Ming, Y., Xue, L., Fei, S., & Meijia, L. (2019). Study on the Critical Production Calculation Method of the Water-Flooding Reservoir with Gas Cap. *Open Journal of Yangtze Gas and Oil, 4*(01): 31-42.

[8]. Oloro, J. O., & Adewole, E. S. (2019). Derivation of Pressure Distribution Models for Horizontal Well Using Source Function, *J. Appl. Sci. Environ. Manage*, *23*(4) : 575-583.

[9]. Orene, J. J., & Adewole, E.S. (2020). Pressure Distribution of a Horizontal Well in a Bounded Reservoir with Constant Pressure Top and Bottom. *Nigerian Journal of Technology (NIJOTECH) 39*(1): 154-160.

[10]. Uwailalyare, Jill K. Marcelle-de Silva, (2011) Effect of Gas Cap and Aquifer Strength on Optimal Well Location for Thin-Oil Rim Reservoirs, DOI: 10.2118/158544-MS.

[11]. Obibuike, U. J., Ekwueme, S. T., Ohia, N. P., Igwilo, K. C., Igbojionu, A. C., & Kerunwa, A. (2019). Mathematical Approach to Determination of Optimum Oil Production Rate in Oil Rim Reservoirs. *Petroleum Science and Engineering*, *3*(2): 60-67.

[12]. Oluwasanmi A. Olabode (2020). Effect of water and gas injection schemes on synthetic oil rim models. *Journal of Petroleum Exploration and Production Technology,* 1-17.

How to cite this article: Oloro, J. O. and Okpeki, U. K. (2020). Horizontal Well in an Infinite Reservoir with Top Gas Cap. *International Journal on Emerging Technologies, 11*(5): 638–641.