ISSN No:-2456 –2165

Determination of Effect of Well Parameters Using Pressure Derivative for Horizontal Wells in Layered Reservoir

Oloro John
Senior Lecturer
Delta State University
Abraka, Delta State
Nigeria

Abstract:- Effect of well parameters using pressure derivative distribution of horizontal wells in a layered reservoir which is subjected simultaneously by two drives mechanism was carried out using source function.Results of the study shows that pay thickness h_D, well length and wellbore radius of a particular layer affect the pressure derivative distribution .

Keywords: Pressure, Derivative, Well, Reservoir, Horizontal

I. INTRODUCTION

The well test derivative function is a tool for interpreting well test behaviour.(Hosseinpour-zonoozi etal,2006)

The pressure derivative application in oil well test analysis involves the combined use of type curves in both the conventional dimensionless pressure form (P_D) and the dimensionless pressure derivative grouping. This method minimizes the problem in type curve matching and gives reliable results. In this paper effect of well parameter on pressure derivative will be study such as pay thickness h_D, well length and wellbore radius.

Model for the reservoir system describing pressure and pressure derivative distribution was developed considering horizontal wellbore and reservoir layer properties using source and Green's functions[1] .The model diagram is shown in Fig.1.0.Reservoir and well properties used in this paper are obtained from [2].

II. THODOLOGY

The method and procedure of determining effect of well parameters using pressure derivative distribution of horizontal wells in a layered reservoir which is subjected simultaneously by two drives mechanism are set out below.

- Selection of appropriate source functions[3]. Derivation of dimensionless pressure and derivative expressions.
- Determination of time normalization factor (α)[4].
- Determination of fluid mobility ratio[2]
- Determination of flow periods.
- Determination of individual layers pressure derivative expressions.
- Production of derivative type curves
- Determination of effects of well parameters on wellbore pressure derivative distribution.

A. Model for Layer 1

Equations 1.0 and 2.0 represent dimensionless pressure and dimensionless pressure derivatives for Layer 1 and Layer 2 respectively. In the derivative plot as shown in figs. 1.0 and 2.0, the derivatives collapse to zero rapidly. If there is depression it indicates that a constant pressure boundary has been encountered. The derivative plots help in identifying each flow period.

ISSN No:-2456 –2165

$$P_{D1} = -\frac{\beta}{4_{L_{D1}}}\int_0^{t_D} \varphi_1 \partial\tau + 2\pi\, h_{D1} A_1 \int_{t_{De}}^{t_{Dz}} \varphi_2 \varphi_3 \varphi_4 \partial\tau + 2\pi\, h_{D1} A_1 \int_{t_{Dz}}^{t_D} \varphi_5 \varphi_6 \varphi_7 \partial\tau \quad (1)$$

$$P_{D1d} = -\frac{\beta}{4L_{D1}}\varphi_{1d} + 2\pi h_{D1} A_1 \varphi_{2d}\varphi_{3d}\varphi_{4d} + 2\pi h_{D1} A_1 \varphi_{5d}\varphi_{6d}\varphi_{7d} \quad (2)$$

For equation 1.0

$$\varphi_{1,i} = \frac{e^{-\frac{(y_D - y_{wD})^2 + (Z_D - Z_{wD})^2}{4\tau}}}{\tau} \quad (3)$$

$$\varphi_{2,i} = \left[e^{-\frac{(y_D - y_{wD})^2}{4\tau}} \right] \quad (4)$$

$$\varphi_{3,i} = \left[erf\, \frac{\left(\sqrt{\frac{k}{k_x}} + x_D\right)}{2\sqrt{\tau}} + erf\, \frac{\left(\sqrt{\frac{k}{k_x}} + x_D\right)}{2\sqrt{\tau}} \right] \quad (5)$$

$$\varphi_{4,i} = \left[1 + 2\sum_{n=1}^{\infty} \exp\left(\frac{n^2 \pi^2 \tau}{h_D^2} \right) \cos n\pi \frac{Z_D}{h_D} \cos n\pi \frac{Z_{wD}}{h_D} \right] \quad (6)$$

$$\varphi_{5,i} = \left[1 + \frac{4 x_{eD}}{\pi} \sum_{n=1}^{\infty} \frac{1}{m} \exp\left(\frac{-m^2 \pi^2 \tau}{xeD^2} \right) \sin \frac{\pi m}{2xeD} \cos \frac{m\pi\, xeD}{xeD} \cos \frac{\cos m\pi\, xD}{xeD} \right] \quad (7)$$

$$\varphi_{6,i} = \frac{1}{y_{eD}} \left[1 + 2 \sum_{n=1}^{\infty} \exp\left(\frac{-m^2 \pi^2 \tau}{y_{eD}^2} \right) \cos \frac{m\pi\, y_{wD}}{y_{eD}} \cos \frac{m\pi\, y_D}{y_D} \right] \quad (8)$$

ISSN No:-2456 –2165

$$\varphi_{7,i} = \left[\frac{1}{h_D} \sum_{n=1}^{\infty} \exp \frac{\left(-(2n-1)^2\right)\pi^2 \tau}{4 h_D^2} \cos \frac{(2n-1)\pi z_{wD}}{h_D} \cos \frac{(2n-1)\pi z_D}{h_D} \right] \quad (9)$$

i=1,2----no of layers

Where

$$\varphi_{2d} = \left[e^{-\frac{(y_D - y_{wD})^2}{4 t_D}} \right] \quad (10)$$

$$\varphi_{3d} = \left[erf \frac{\left(\sqrt{\frac{k}{k_x}} + x_D\right)}{2\sqrt{t_D}} + erf \frac{\left(\sqrt{\frac{k}{k_x}} - x_D\right)}{2\sqrt{t_D}} \right] \quad (11)$$

$$\varphi_{4d} = \left[1 + 2\sum_{n=1}^{\infty} \exp\left(\frac{n^2 \pi^2 t_D}{h_D^2} \right) \cos n\pi \frac{Z_D}{h_D} \cos n\pi \frac{Z_{wD}}{h_D} \right] \quad (12)$$

$$\varphi_{5d} = \left[1 + \frac{4 x_{eD}}{\pi} \sum_{n=1}^{\infty} \frac{1}{m} \exp\left(\frac{-m^2 \pi^2 t_D}{xeD^2} \right) \sin \frac{\pi m}{2xeD} \cos \frac{m\pi\, xeD}{xeD} \cos \frac{\cos m\pi\, xD}{xeD} \right] \quad (13)$$

$$\varphi_{6d} = \frac{1}{y_{eD}} \left[1 + 2 \sum_{n=1}^{\infty} \exp\left(\frac{-m^2 \pi^2 t_D}{y_{eD}^2} \cos \frac{m\pi\, y_{wD}}{y_{eD}} \cos \frac{m\pi\, y_D}{y_D} \right) \right] \quad (14)$$

ISSN No:-2456 –2165

$$\varphi_{7d} = \left[\frac{2}{h_D} \sum_{n=1}^{\infty} \exp \frac{\left(-(2n+1)^2\right)\pi^2 t_D}{4h_D^2} \cos \frac{(2n+1)\pi z_{wD}}{h_D} \cos \frac{(2n+1)\pi z_D}{h_D} \right] \tag{15}$$

Model for Layer 2

$$P_{D2} = -\frac{\beta}{4L_{D2}} \int_0^{t_D} \varphi_1 \partial\tau + 2\pi h_{D2} A_2 \int_{t_{De}}^{t_{Dz}} \varphi_2 \varphi_3 \varphi_4 \partial\tau + 2\pi h_{D1} A_2 \int_{t_{Dz}}^{t_D} \varphi_5 \varphi_6 \varphi_7 \partial\tau \tag{16}$$

$$P_{D2d} = -\frac{\beta}{4L_{D2}} \int_0^{t_D} \varphi_{2d} \partial\tau + 2\pi h_{D2} A_2 \int_{t_{De}}^{t_{Dz}} \varphi_{2d} \varphi_{3d} \varphi_{4d} \partial\tau + 2\pi h_{D2} A_2 \int_{t_{Dz}}^{t_D} \varphi_{5d} \varphi_{6d} \varphi_{7d} \tag{17}$$

B. Constants (A_1 and A_2) at the Interface

Factors, A_1 and A_2 are introduced such that if obtained would amend for the assumption of a constant-pressure boundary and duplicate the influence of the interface more properly [3]

To obtain the expressions for the above constants (A_1 and A_2), boundary conditions come to play at the interface. That is, Equation 18.0 and 19.0.

$$P_{D1}=P_{D2} \tag{18}$$

$$\frac{\partial p_{D1}}{\partial z_D} = M \frac{\partial p_{D2}}{\partial z_D} \tag{19}$$

From Equations 18.0 and 19.0 we have,

$$A_1 = \frac{M P_{2i} V + Vd P_{2i}}{M p_i + d P_i P_{2i}} \tag{20}$$

$$A_2 = \frac{V A_1 d P_i}{Md P_{2i}} \tag{21}$$

Where

$$P_{2i} = 2\pi h_{D2} \int_{tDe}^{tDZ} \left[e^{-\frac{\left(y_{D2}-y_{wD2}\right)^2}{4\tau}} \right] * \left[erf \frac{\left(\sqrt{\frac{K}{k_X}} + X_{D2}\right)}{2\sqrt{\tau\alpha}} + erf \frac{\left(\sqrt{\frac{K}{k_X}} - X_{D2}\right)}{2\sqrt{\tau\alpha}} \right] * \tag{22}$$

$$\left[1 + 2\sum_{n=1}^{\infty} \exp\left(\frac{n^2 \pi^2 \tau\alpha}{h_{D2}^2} \right) \cos n\pi \frac{Z_{D2}}{h_{D2}} \cos n\pi \frac{Z_{wD2}}{h_{D2}} \right]$$

$$V = \frac{\beta}{4L_{D2}} \int_0^{t_D} \frac{ -\frac{\left(Y_D - Y_{WD2}\right)^2 + \left(Z_{D2} - Z_{WD2}\right)^2}{4\tau} }{\tau} d\tau - \frac{\beta}{4L_{D1}}$$

$$\int_0^{t_D} \frac{ -\frac{\left(Y_D - Y_{WD1}\right)^2 + \left(Z_{D1} - Z_{WD1}\right)^2}{4\tau} }{\tau} d\tau \tag{23}$$

$$P_i = 2\pi h_{D1} \int_{tDe}^{tDZ} \left[e^{-\frac{\left(y_{D1}-y_{wD1}\right)^2}{4\tau}} \right] * \left[erf \frac{\left(\sqrt{\frac{K}{k_X}} + X_{D1}\right)}{2\sqrt{\tau\alpha}} + erf \frac{\left(\sqrt{\frac{K}{k_X}} - X_{D1}\right)}{2\sqrt{\tau\alpha}} \right] * \tag{24}$$

$$\left[1 + 2\sum_{n=1}^{\infty} \exp\left(\frac{n^2 \pi^2 \tau\alpha}{h_{D1}^2} \right) \cos n\pi \frac{Z_{D1}}{h_{D1}} \cos n\pi \frac{Z_{wD1}}{h_{D1}} \right] d\tau$$

$$\partial P_i = -\frac{\pi}{h_{D1}} \left[e^{-\frac{\left(Y_{D1} - Y_{WD1}\right)^2}{4\tau}} \right] * \left[erf \frac{\left(\sqrt{\frac{K}{K_x}} + x_{D1}\right)}{2\sqrt{\tau}} + erf \frac{\left(\sqrt{\frac{K}{K_x}} - x_{D1}\right)}{2\sqrt{\tau}} \right]$$

$$* \left[1 + 2\sum_{n=1}^{\infty} \exp\left(\frac{n^2 \pi^2 \tau}{h_{D1}^2} \right) \sin\left(\frac{n\pi Z_{D1}}{h_{D1}} \right) Cos\left(\frac{n\pi Z_{WD1}}{h_{D1}} \right) \right] d\tau \tag{25}$$

ISSN No:-2456 –2165

III. RESULTS AND DISCUSION

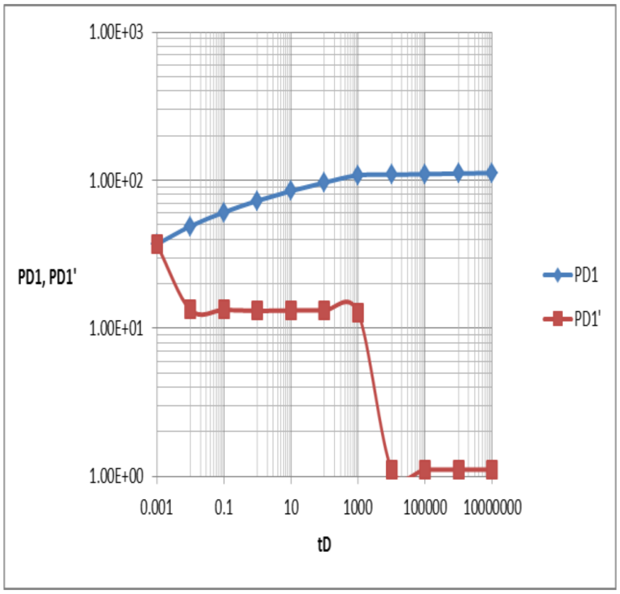

Fig. 1.0: Dimensionless Pressure and Dimensionless Pressure Derivative for Layer1

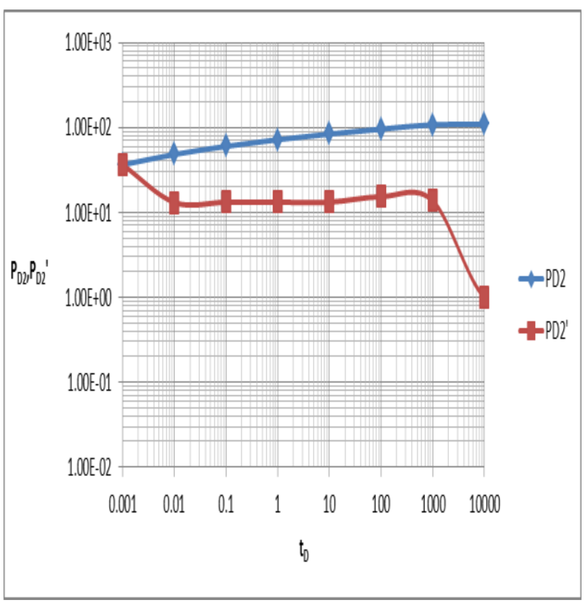

Fig. 2.0: Dimensionless Pressure and Dimensionless Pressure Derivative for Layer 2

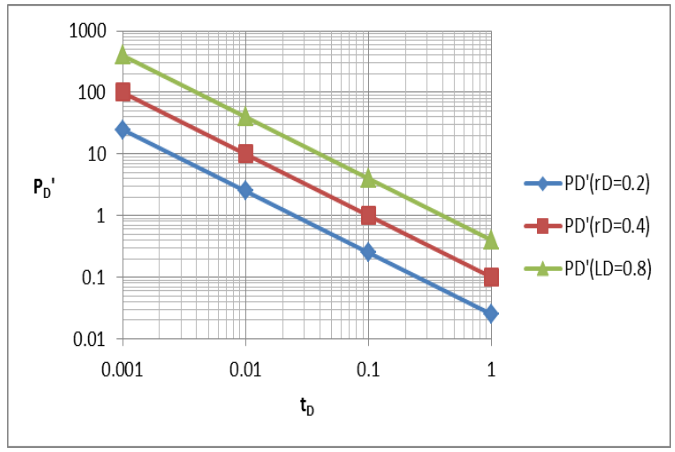

Fig.3.0: Effect of wellbore radius on Pressure derivative distribution

Fig.3.0 illustrate effect of wellbore radius on pressure derivative distribution, and it is observed that the larger the wellbore radius the higher the productivity.

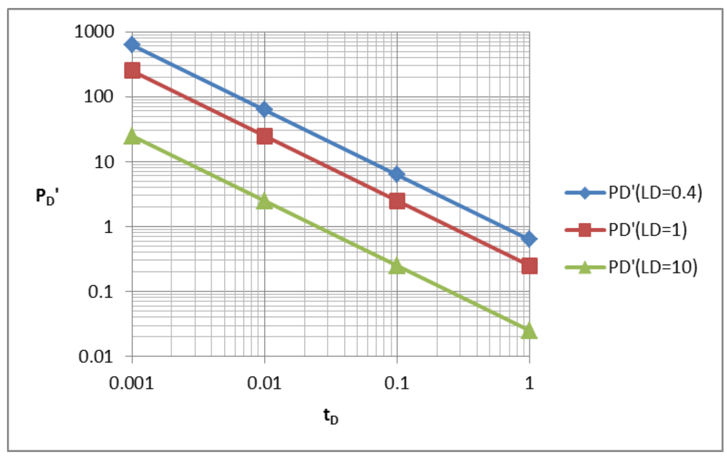

Fig.4.0: Effect of Well length on pressure derivative distribution

.Fig.4.0 illustrates the effect of well length on pressure derivative. It is observed that the shorter the well length the higher the productivity.

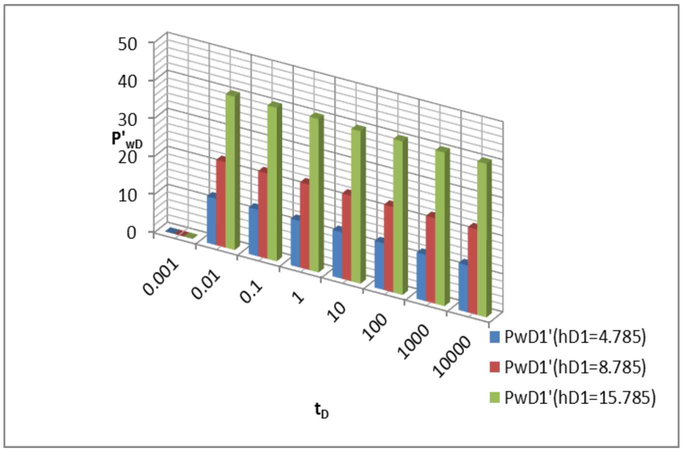

Fig.5.0: Effect of Pay thickness on pressure derivative distribution

To determine the effect of change in h_{D1} on P_{wD1}' . P_{wD1}' was computed with values of h_{D1} of 4.785, 8.785 and 15.785.While h_{D2} remain constant at 6.5298. The results are shown in Fig.5.0 . It is observed that the thicker the pay thickness the higher the productivity.

IV. CONCLUSIONS

From the statement of problems, objectives, and the results of study presented in the previous chapters, the following conclusions can be drawn:

1The results of dimensionless pressure showed constant values at late flow time while the dimensionless derivatives collapse to zero rapidly.

2. It is possible to analyze each layer.3. When there is crossflow, pressure transient in the reservoir considered

is similar to the behavior of the homogeneous system.

3.The thicker the pay thickness of a particular layer the higher the wellbore pressure and wellbore pressure derivative of that particular layer.

4 The following also affects the pressure responses: (i)Interlayer fluid mobility ratio(ii) time Normalization factor

5. In order to obtain high productivity, larger wellbore radius should be used.

REFERENCES

[1] A.C Gringarten and H.J Ramey, The Use of Source and Green's Functions in Solving Unsteady-Flow Problems in Reservoirs, 1973.

[2] J.Oloro, E.S Adewole and O.A Olafuyi, Pressure Distribution Of Horizontal Wells In A Layered Reservoir with Simultaneous Gas Cap and Bottom Water Drive" American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-03, Issue-12, pp-41-53,2014

[3] E.S..Adewole. and O.A Olafuyi.,The use of source and Green's functions to derive dimensionless pressure and dimensionless pressure derivative distribution of A two-layered reservoir, PART:A-SHAPED ARCHITECTURE ''Journal of Mathematics and Technology,April,2010.

[4]. M.D Clonts., and H.J Ramey,Pressure Transient Analysis for wells with Horizontal drainholes'',56th California Regional Meeting of the Society of Petroleum Engineers held in Oakland.C.A.April 2-4, 1986.