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Analysis of Production using a Simple Approach in Fractured Reservoir

Sri Feni Maulindani*, Pauhesti Rusdi, Andry Prima
Petroleum Engineering Department, Faculty of Earth Technology and Energy, Universitas Trisakti, Indonesia
**Corresponding Author*

ABSTRACT: *More than 50% the production coming from the fractured reservoir, this happen to be the typical of porous media that contain vugs, fractures and matrix that carried on the huge storage fluids in this reservoir. Thereof the characteristics different from homogenous system, where there are two porous media that are matrix and fracture, which is dominantly oil fluid to flow from fractures to the wellbore, and also is not easy to predict the behavior of this reservoir. This study focusses on estimating the reservoir parameter from analyzing from production data from the reservoir, which is complicated to identifying and characterizing the dual porosity model in naturally fractured reservoir. The fluids mechanism of this study is using the Warren and Root model or Pseudo-steady state flow. Mostly authors use the pressure transient analysis to estimating the characteristic of the reservoir. The result of the study is using the synthesis data simulation to be applied using type curve matching that developed from analytical solution in Laplace domain in order to define the fractured permeability, storativity capacitance (ω), interporosity flow coefficient (λ) and boundary.*
KEYWORDS:

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I. INTRODUCTION

Production analysis in Naturally Fractured Reservoirs (NFR) is challenging in order to characterize the reservoir. There are two porous media in this unique reservoir such as matrix porous and fractures porous. The fractures have a higher flow rate but a lower in storage capacity, the matrix have a higher capacity for storage but a lower flow capacity. (Warren & Root, 1963) developed an idealized model for study of fluid flow in heterogeneous reservoirs (double porosity model), as shown in Figure 1. The model is composed of rectangular parallelepipeds where is the blocks delineate to be the matrix and the space in between delineate to be the fractures. The familiar supposition of the model is homogenous and isotropic of the two porous medium, similar block-size classification, and occasion of fluid flow from matrix to fracture and from fracture flow to well, but not amongst matrix elements. The interporosity flow of this model (fluid mechanism from matrix to fractures) is pseudosteady state flow.

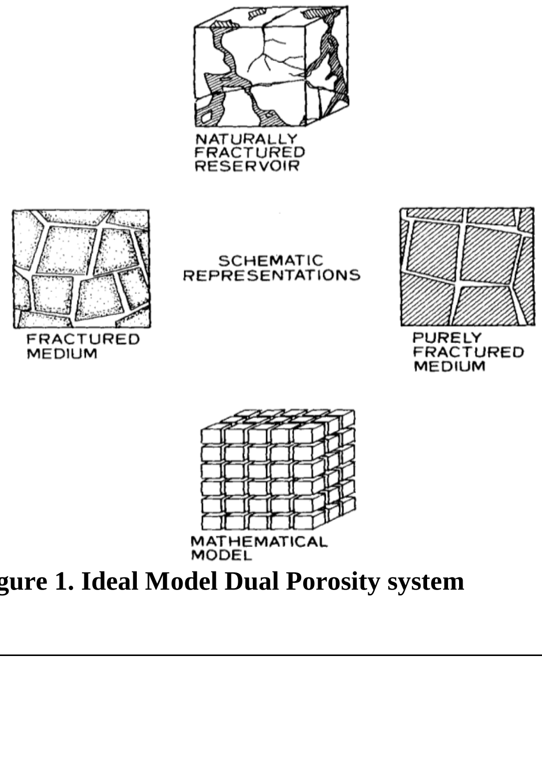

Figure 1. Ideal Model Dual Porosity system

[2],Present the model of dual porosity in slab form for unsteady in the radial and vertical directions, and fluid mobility from the matrix (which has high storage and a very low flow capacity) to fracture (which has a high flow rate and a small amount of storage). The pressure transient analysis for dual porosity is initiated by [3], the result of their study about the pressure dimensionless for infinite and finite reservoir using analytical solution. Well test analysis for naturally fractured reservoir as shown in figure 2, present the mechanism of flow between the matrix and fracture, which is known with S shape for identification of the reservoir behavior. There are three times region for this reservoir that indicate the flow regime in the reservoir and yield two straight lines in transition part between two slopes.

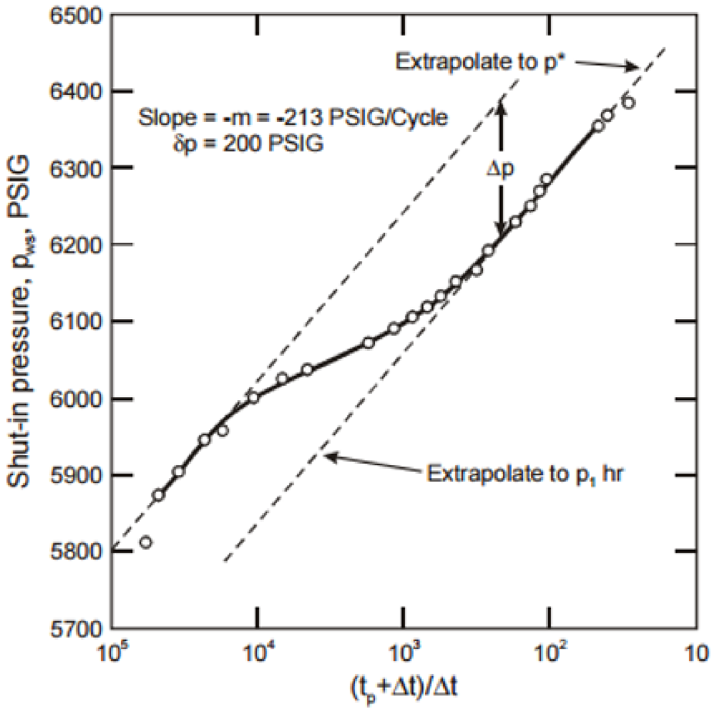

Fig 2. Pressure Build Up Test for Naturally Fractured Reservoir

The limitations of the dual-porosity method in handling more intricate reservoirs have previously been examined by authors. [4] presented analytical solutions methods for interporosity transient flow with various geometries that already done by Kazemi. Later, [5] extended the theory to include the transition period. [6] considered a theoretical circular model with a centrally located well and a vertical fracture nearby the well, and also considered the effect of fracture orientation on pressure response. [7] introduced the triple porosity model to define the behavior of naturally fractured, although the Warren and Root theory has been modified to account for various matrix-to-fracture flow regimes, wellbore storage, and skin, it is still the most popular well test analysis technique for naturally fractured reservoirs. As a result, the parameters are valid for describing those reservoirs. also [8], present the pressure transient analysis using generated data simulated for two flow mechanism that of dual porosity model to describe the behavior of the naturally fractured oil reservoir. Other than analysis pressure data, there are analysis the flow rate data that is discussed in this as a simple approximation using analytical solution for estimation the reservoir parameter of this unique reservoir. This is done without any shut down the well so there is no decline of oil production in the well or oil field. [9], present the application of decline rate type curve to calculate the reservoir parameter using SF field.

II. METHODS AND DATA

- **Diffusivity equation for Naturally Fractured Reservoir (dual Porosity)**

In this part discussed mainly the fundamental partial differential equation for establish the pressure reservoir performance of dual porosity in naturally fractured reservoir. This equation is first proposed by [1] for describing the behavior of flow mechanism in matrix and fractured in the reservoir. Also, this also known as diffusivity equation for naturally fractured reservoir. This equation has been used by authors for many years to describe the characteristic of the dual porosity and many author extended and modified this equation to solve performance problem of reservoir specially this unique reservoir. [11], use the equation to study the characterization using dimensionless flow rate in producing at constant inner pressure for the no-flow boundary and bounded dominated flow reservoir. Their studies continue by [12], by adding the wellbore storage effect and skin factor in dimensionless flow rate for finite and infinite reservoir Pseudosteady-state flow. The diffusivity equation;

$$\frac{\partial^2 P_{fD}}{\partial r_D^2} + \frac{1}{r_D}\frac{\partial P_{fD}}{\partial r_D} = (1-\omega)\frac{\partial P_{mD}}{\partial t_D} + \omega\frac{\partial P_{fD}}{\partial t_D} \qquad (1)$$

Mechanism of fluid flow from matrix to fracture pressure for steady state relation are:

$$(1-\omega)\frac{\partial P_{mD}}{\partial t_D} = \lambda\left(P_{fD} - P_{mD}\right) \qquad (2)$$

Where omega (storage capacity coefficient) is dimensionless parameter are:

$$\omega = \frac{(\phi C_t)_f}{(\phi C_t)_f + (\phi C_t)_m} \qquad (3)$$

Lamda (interflow Coeficient flow) is dimensionless matrix to fracture permeability ratio are:

$$\lambda = \alpha\frac{k_m r_{w^2}}{k_f h_{m^2}} \qquad (4)$$

Boundary of Reservoir r_{eD} are:

$$r_{eD} = {}^{r_e}/_{r_w} \qquad (5)$$

Flow rate dimensionless and time dimensionless are define as:

$$q_D = \frac{141.2 q \mathrm{B}\mu}{k_f h\left(p_i - p_{wf}\right)} \qquad (6)$$

$$t_D = \frac{0.0002637 k_f t}{(\phi C_t)_{m+f} r_w^2} \qquad (7)$$

The solution for equation (1) and equation (2) within context initial condition and boundary condition for fracture system is follow consideration that;

Initial condition,

$$P_{fD}(r_D, 0) = 0 \qquad (8)$$

Inner boundary condition at constant rate is;

$$P_{fD-S}\left(\frac{\partial P_{fD}}{\partial t_D}\right)_{rD=1} = 1 \qquad (9)$$

Where S is the skin factor. There are two outer boundary condition are applied in the diffusivity equation such as; infinite reservoir and bounded reservoir.

Infinite reservoir condition,

$$\lim_{r_{D\to\infty}} P_{fD}(r_D, t_D) = 0 \qquad (10)$$

closed-outer-boundary condition,

$$\left.\frac{\partial P_{fD}}{\partial t_D}\right|_{rD=r_{eD}} = 0 \qquad (11)$$

The performance of a conventional reservoir, closed-outer-boundary reservoir has been studied by many authors. [13] give a solution for the cumulative production for the case of constant terminal pressure. Da Prat et al. (1981a), the solution for the dimensionless flow rate, q_D, in Laplace space

Estimate fracture permeability,

$$k_f = \frac{141.2\mu B}{h(pi - pwf)} \frac{[q]_{MP}}{[q_D]_{MP}} \tag{12}$$

Estimate total storativity,

$$\left[(\phi Vc)_m + (\phi Vc)_f\right] = \frac{2.637(10^{-4})k_f}{\mu r_w^2} \frac{[t]_{MP}}{[t_D]_{MP}} \tag{13}$$

- **Synthesis reservoir simulation data**

The production data is build using synthesis reservoir simulation based on previously study [10]. The synthesis data generated using simulator commercial black oil, oil phase, radial grid, shape factor Warren and Root and undersaturated reservoir condition. The reservoir data from simulated are with the following consideration such as: the reservoir has production constrain about 1000 bopd with reservoir pressure about 4000 psia. The time step that used in this study is about 360 days and produce constants rate and wellbore pressure. The fluid and rock type of this simulation use the correlation and no capillary pressure neither for rock matrix and fracture.

III. RESULTS AND DISCUSSION

Producing well from the naturally fracture need more attention regarding the decline flow rate rapidly as a presence due of the fractures, where mainly flow rate produce through the fracture network. Hence, fractures have higher permeability that the matrix, still need to investigate deeply of the production from this reservoir, where initially higher production then decline rapidly. This a typical of naturally fracture reservoir that happen in the well and field. This study is applied the production data from the synthesis reservoir simulation with an analytical solution using Gavest stehfest algorithm in form Laplace domain in real domain. The analysis of the production data using a log- log type curve matching is presented as shown in figure 4. The production rate is overlay above the type curve that appropriate with $\omega = 0.03$, $\lambda = 1.54x10^{-5}$, and $r_{eD} = 200$

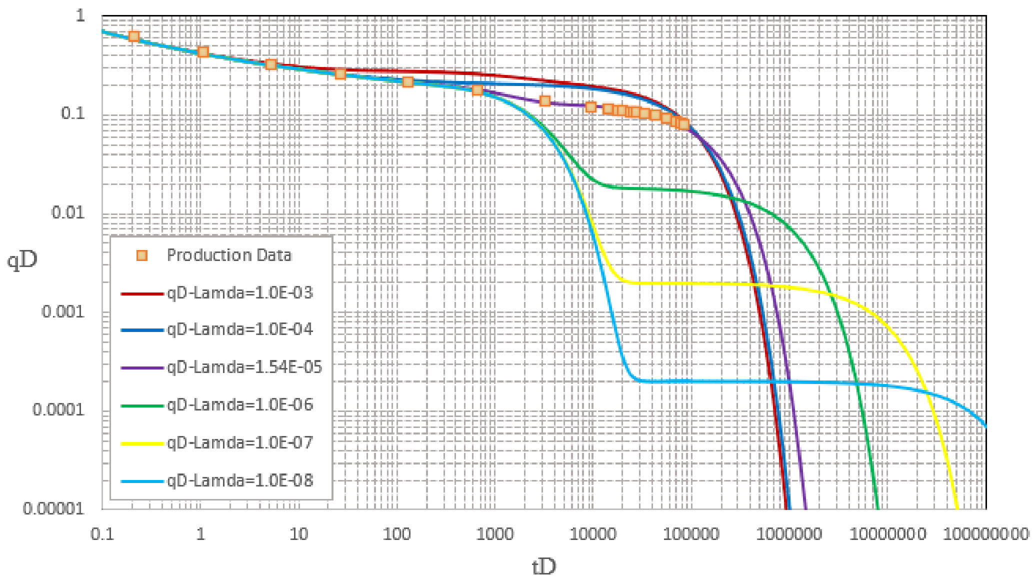

Fig. 4 Dimensionless flow rate for Pseudosteady-state Flow model. $\omega = 0.03, r_{eD} = 200$ for various λ.

After match point with the type curve suitable with the production data, we can calculate the fracture permeability and total storativity using equation (12) and (13) the result of type curve matching is shown in the table 2

Table 2. Result from Analysis of Production

Type Curve Matching			
$[t]_{MP}$	1.42	$[q]_{MP}$	74.2
$[t_D]_{MP}$	1	$[q_D]_{MP}$	1
Fracture Permeability, k_f	88	ω	0.03
λ	$1.54x10^{-5}$	$\left[(\phi Vc)_m + (\phi Vc)_f\right]$	$7.66x10^{-7}$

IV. CONCLUSION

This study is conducted for the specified the reservoir characteristic in naturally fracture reservoir, with production scenario that describing the flow rate performance in dual porosity and also identification the behavior of the reservoir through daily production data. From the result of the study, estimating the reservoir parameter that influence the performance of production of well, where fracture permeability, storativity ratio and interporosity flow coefficient that effect the flow of the oil production to the wellbore. Analysis the production data using dimensionless flow rate that developed using analytical solution can yield appropriate the reservoir parameter, instead pressure transient analysis by shut down the well. Even though, need a variety of dimensionless flow rate that suitable with the synthesis simulated data, and yield significant reservoir parameter of this reservoir.

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