# Error Generated due to Inaccuracy in Payzone Thickness While Interpreting Multiphase Flow Buildup Well Test Data

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**Abstract:** While performing reservoir related studies either conducted by an engineer or a production geologist, one have to deal with number of uncertainties arising from different sources based on the manner by which different properties required to be used as an input while evaluating buildup well test data. Out of the required input parameters, payzone thickness have a kind of key significance, as most of the well test estimated data is directly or either indirectly depend on it. Most of the petroleum reservoirs have multiphase flow, so in this study buildup test data for multiphase flow have been analyzed while incorporating the payzone thickness uncertainty.

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**Keywords:** multiphase fluid reservoir; multiphase well test data; payzone uncertainty

## 1. Multiphase Flow Buildup Test Data Interpretation

In our previous studies (Zahoor and Khan,2012[1];Zahoor and Khan,2012[2]) effect of uncertainties in formation thickness values on well test data interpretation for gas and oil reservoirs have been discussed. Here the study is extended to reservoirs producing multiphase flow. In a reservoir whether it is declared as gas or oil producing formation, encountering multiphase flow is a common phenomenon. In case of gas reservoirs; flow of gas, water and gas condensate might exists at a time and similarly as a general practice gas and water is produced with oil as a main stream in case of oil reservoirs. After drilling upto or through the pay, well test is conducted to have a prime knowledge of reservoir behavior, expected fluids flow rate and other fluid and reservoir properties. Payzone thickness has great significance in performing fluid in place calculations and also to estimate/predict various reservoir properties. Today, different techniques are available in the industry to measure payzone thickness as accurate as possible. But due to different limitations of these techniques accuracy of the measured value ranges between five to sixty percent, which has also been used in earlier research(Zahoor and Khan,2012[1];Zahoor and Khan,2012[2];Siemek and Nagy,2004). Here a research has been conducted to analyze the effect of such uncertainty on buildup test data interpretations, conducted on a well producing, gas, oil and water.

In this study, the methodology proposed by Perrine (Perrine,1956) has been adopted, because of vast acceptability in such cases and has also been discussed number of time in the literature. Briefly, the respective approach can be described as below and further details can be found in literature(Lee, Rollins and Spivey,2003;Bourdarot,1996;Jun and Minglu,2011).

Effective fluid (gas, oil and water) permeabilities can be calculated by using the following equations (1-3):

$$k_g = \frac{162.5\left(q_{gt} - q_o R_s \times 10^{-3}\right) B_g \mu_g}{mh} \quad (1)$$

$$k_o = \frac{162.5 q_o B_o \mu_o}{mh} \quad (2)$$

$$k_w = \frac{162.5 q_w B_w \mu_w}{mh} \quad (3)$$

While the total mobility and skin can be estimated by using eqs. (4 & 5).

$$\lambda_{total} = \frac{162.6\left[q_o B_o + q_w B_w + \left(q_{gt} - q_o R_s \times 10^{-3}\right) B_g\right]}{mh} \quad (4)$$

$$s = 1.151\left[\frac{\left(p_{1hr} - p_{wf}\right)}{m} - \log\left(\frac{\lambda_{total}}{\phi c_t r_w^2}\right) + 3.23\right] \quad (5)$$

## 2. Mutliphase Fluid Flow Properties and Well Data: A Case Study

The following is the well test and fluid properties used in this study, as mentioned in table 1:

Table 1: Parameter used for analysis

| | |
|---|---|
| $q_{gt}$ | 1332 MScf/d |
| $q_o$ | 1595 Stb/d |
| $q_w$ | 409 Stb/d |
| $R_s$ | 240 Scf/Stb |

| | |
|---|---|
| $\mu_o$ | 0.524 cp |
| $\mu_g$ | 0.0166 cp |
| $\mu_w$ | 0.313 cp |
| $B_o, B_g, B_w$ | 1.214, 1.579, 1.008 |
| $c_o, c_g, c_w$ | 0.0001, 0.00041, $9.8 \times 10^{-6}$ $psi^{-1}$ |
| $\phi$,h (deterministic) | 0.198 %, 55 ft |
| $P_{wf}, p_{1hr}$ | 1656, 1888 psia |
| $S_g, S_w$ | 12.5, 38.2 |

## 3. Results and Discussion

The obtained results based on the above mentioned methodology are given in table 2, while incorporating uncertainty in formation thickness.

Table2. Effect of pay zone uncertainty on well test Interpretation

| h | $k_g$ | $k_o$ | $k_w$ | $\lambda_{total}$ | s |
|---|---|---|---|---|---|
| *1. Uncertainty due to core analysis* | | | | | |
| 49.5 | 0.67 | 27.1 | 3.45 | 103.1 | -3.2 |
| 55 | 0.6 | 24.4 | 3.1 | 92.8 | -3.12 |
| 60.5 | 0.54 | 22.2 | 2.8 | 84.3 | -3.07 |
| *2. Uncertainty due to log analysis* | | | | | |
| 44 | 0.75 | 3.56 | 3.9 | 116 | -3.23 |
| 55 | 0.6 | 24.25 | 3.11 | 92.8 | -3.13 |
| 66 | 0.5 | 20.4 | 2.6 | 77.3 | -3.03 |
| *3. Uncertainty arising from geological interpretation* | | | | | |
| 22 | 1.5 | 61.13 | 7.8 | 232 | -3.58 |
| 55 | 0.6 | 24.45 | 3.1 | 92.8 | -3.13 |
| 88 | 0.37 | 15.3 | 1.9 | 58 | -2.891 |

The obtained results show that the as the thickness increases, effective permeability of the fluids flowing in a reservoir decreases. As the mobility or total mobility is strongly based of these effective permeabilites, so as a result it also decreases. The same is the case with formation damage or skin. The negative sign with the skin factor "s", shows stimulation, so in this cases the stimulating effect decreases with the increase in payzone thickness.

## 4. Conclusions and Recommendations

Inaccuracy in formation thickness measurement (IFTM) has strong influence on set of information derived from multiphase flow well test data (IMWTD). Generally, on most of the calculated parameters included in this study and earlier studies conducted by us (Zahoor and Khan,2012[1];Zahoor and Khan,2012[2]), IFTM has inverse effect, i.e., as IFTM decreases, most of the significant paramaters value, increases.

These set of studies show that uncertainty in formation or payzone thickness should be handled carefully to have better well test data interpretation and also the time to conduct such tests should be reduced, especially in the cases where there is lack of surface facilities to handle and process the produced fluids in an appropriate manner.

## 5. Nomenclature

| | |
|---|---|
| B | formation volume factor |
| $c_t$ | total compressibility |
| g,o,w | subscripts: gas, oil and water |
| h | formation thickness |
| k | permeability |
| m | slope |
| p | pressure |
| $p_{wf}$ | wellbore flowing pressure |
| q | flow rate |
| $q_{gt}$ | total gas produced |
| $r_w$ | wellbore radius |
| s | skin |
| $\phi$ | porosity |
| $\mu$ | viscosity |

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**References**

1. Zahoor M. K. and Khan A. Impact of Uncertainties in Formation Thickness on Parameters Estimated from Well Testing Part 1: Gas Reservoirs. Life Science Journal 2012; accepted, in press.
2. Zahoor M. K. and Khan A. Impact of Uncertainties in Formation Thickness on Parameters Estimated from Well Testing Part 2: Oil Reservoirs. Life Science Journal 2012; accepted, in press.
3. Siemek J. and Nagy S. Estimation of Uncertainles in Gas-Condensate Systems Reserves by Monte Carlo Simulation. Acta Montanistica Slovaca 2004; 9 (3):289-293.
4. Perrine R. L. Analysis of Pressure Buildup Curves. American Petroleum Institute. 1956.
5. Lee J., Rollins J. B. and Spivey J. P. Pressure Transient Testing. SPE. Texas. 2003.
6. Bourdarot G. Well Testing: Interpretation Methods. Editions Technip. Paris. 1996.
7. Jun Y. and Minglu W. Streamline Numerical Well Test Interpretation: Theory and Methods. Gulf Professional Publishing. USA. 2011.

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