Impact of Uncertainties in Formation Thickness on Parameters Estimated from Well Testing Part 2: Oil Reservoirs

Muhammad Khurram Zahoor[1,*], Azam Khan[1]

[1]Department of Petroleum and Gas Engineering, University of Engineering and Technology, Lahore, Pakistan
[*]Corresponding author: mkzahoor@yahoo.com

Abstract: Formation thickness is of vital significance in estimating different reservoir parameters in oil reservoirs. Any error or uncertainty in formation thickness can contribute as tremendous source of error while estimating different parameters based on well testing, like, permeability, radius of investigation, etc. In this second part of the study, a pressure-buildup test has been analyzed, while incorporating the uncertainties in formation thickness. The effect of these uncertainties has been included in different calculations like, permeability, skin-factor, radius of investigation, wellbore storage, etc. The results show that the uncertainty in formation thickness affects all the aforementioned parameters, though the degree of influence can be different.
[Zahoor M. K., Khan A. **Impact of Uncertainties in Formation Thickness on Parameters Estimated from Well Testing Part 2: Oil Reservoirs**. *Life Sci J* 2012:9(4):475-477] (ISSN:1097-8135). http://www.lifesciencesite.com. 70

Keywords: Oil reservoir; interpretation uncertainty; uncertainty impact

1. Introduction

As discussed previously in Part 1 of the paper(Zahoor and Khan,2012), based on literature survey conducted by Siemek et al.(Siemek and Nagy,2004), uncertainty in measured value of formation thickness (F.H) or pay zone (P.Z) can range from ±5% to ±60%. Furthermore, in previous study conducted by us (Zahoor and Khan,2012) well test data of a gas reservoir was analyzed while taking into account such uncertainties, while here the study has been extended to oil reservoirs.

In this study, a pressure-buildup test conducted after a single constant rate flow has been analyzed while incorporating uncertainty in P.Z thickness value into effective oil permeability, radius of investigation, drainage area and skin-factor.

2. Incorporating Uncertainty in Formation thickness into Various Parameters

Payzone or formation thickness directly influences the permeability which in-turn effects other parameters calculated based on well test(Chaudhry,2004;Chaudhry,2003). This can be explained with the help of a flow chart as shown in figure (1), along with the equations selected from the work accomplished by Lee et al.(Lee, Rollins and Spivey,2003) to be used for their estimation during this study.

3. Analyzing the Impact of P.Z Uncertainty on Welltest data Interpretation

The following set of data has been used to analyze the effect of formation thickness uncertainty on above discussed parameters, as given in table 1.

Table 1: Oil reservoir description and well parameters

Reservoir and Fluid Properties	
	1.132 cp
	39 %
B_o	1.24 RB/STB
p_{1hr}	1647 psia
P_{wf}	1187 psia
$h_{,deterministic}$ value	107 ft
C_t	20.4 x10^{-6} psia^{-1}
m	98.76 psia/cycle
t	67 hours
q_o	489 Stb/day
r_w	0.254 ft

From the deterministic value, using the minimum and maximum possible percentage uncertainty, the resulting values of payzone thickness becomes; 42.8, 101.65, 112.35 and 171.2 ft, which has been used to estimate different parameters calculated from well testing.

4. Results and Discussion

The obtained results using above mentioned data (table 1) and equations expressed in flow chart (figure 1) are shown in figures 2 and 3.

This study shows that, decrease in formation thickness gives a resulting stimulation effect, as reflected by decrease in "s-factor", shifting it to negative value from higher positive. Further, it is noticed that the relationship between formation thickness and the estimated parameters in case of oil reservoir, is the same as in case of gas reservoirs(Zahoor and Khan,2012) and can be summarized as follows (table 2):

Table 2: Influence of F.H on various parameters under consideration

Parameter	Payzone thickness
Permeability, Radius of investigation, drainage Area, effective wellbore radius	Inverse
Skin-factor	Direct

Furthermore, in terms of magnitude the extent can be different in case of gas and oil reservoirs, but still the relative change is same, as shown in figure (4) in case of "s" estimation (even though the deterministic value of formation thickness is different in both cases, i.e., 59 ft(Zahoor and Khan,2012) and 107 feet respectively). The relative change is calculated by using the following equation:

$$\text{Relative change} = \frac{s_{\text{based on max.F.H}} - s_{\text{based on min.F.H}}}{s_{\text{based on max.F.H}}}$$

The obtained relative change value in case of oil and gas reservoirs has also been plotted in figure (4) against their respective maximum formation thicknesses (94.4 ft in case of gas reservoir(Zahoor and Khan,2012) and 171.2 ft in case of oil reservoir).

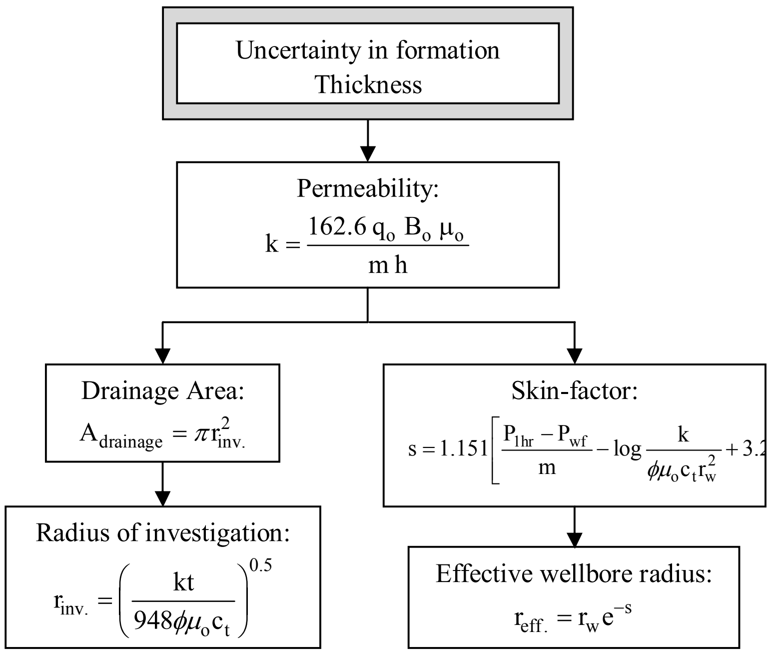

Figure 1: Flow chart and stepwise calculation procedure of calculating different F.H dependent parameters

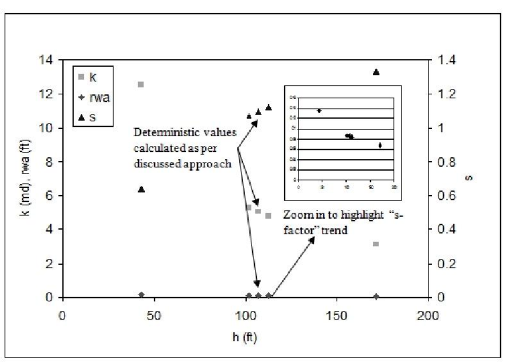

Figure 2. Estimated k, r_{wa} and s-factor based on deterministic value and including degree of uncertainty in formation thickness

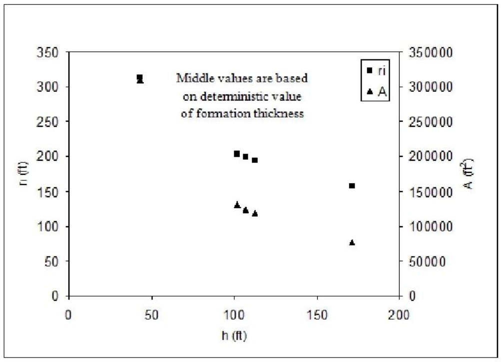

Figure 3. Estimations of "r_i" and "A" based on different values of payzone/ formation thickness

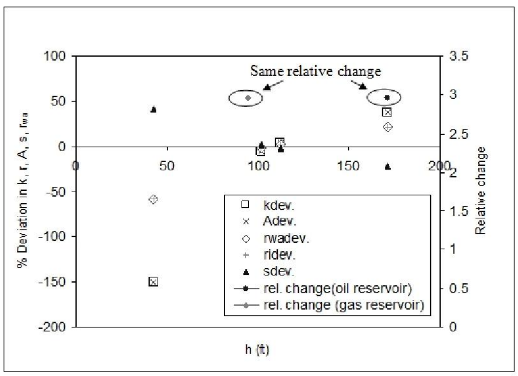

Figure 4: Estimated percentage deviation and relative change in "s"

5. Conclusions and Recommendations

Uncertainty in formation thickness measurement affects various parameters taken into account, during this study. So, special care should be taken in decreasing the magnitude of inaccuracy in formation thickness measurements to have more reliable results, based on which further reservoir studies can be conducted.

Further it can also be concluded that if uncertainty in payzone thickness significantly effects the well test data interpretations in case of single phase flow, then the study should be further extended to multiphase flow reservoirs which are also commonly encountered.

6. Nomenclature

A	area
B_o	oil formation volume factor
C_t	total compressibility
h	formation thickness
k	permeability
m	slope
p	pressure
q_o	oil flow rate
$r_{inv.}$	radius of investigation
r_w	wellbore radius
$r_{eff.}$	effective wellbore radius
s	skin
t	time
	porosity
	viscosity

Corresponding Author:
Dr. Muhammad Khurram Zahoor
Department of Petroleum and Gas Engineering
University of Engineering and Technology, Lahore
Pakistan
E-mail: mkzahoor@yahoo.com

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. 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.
3. Chaudhry A. U. Oil Well Testing Handbbok. Elsevier Inc. USA. 2004.
4. Chaudhry A. U. Gas Well Testing Handbook. Elsevier Inc. USA. 2003.
5. Lee J., Rollins J. B. and Spivey J. P. Pressure Transient Testing. SPE. Texas. 2003.

9/20/2012