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Reserve Estimation of Rashidpur Gas Field Using Typecurve Analysis

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ABSTRACT: Reserve estimation is the fundamental study in the field of petroleum engineering for economic analysis of a reservoir. If a considerable reserve of gas or oil is in place and the pressure is also high enough, then a reservoir can be considered economically viable to go on production. In the early life of the reservoir mainly during or just after exploration; volumetric calculation is the key to estimate reserve. However, it is sometimes invaluable to estimate reserve during production life of the reservoir. Considering this aspect, we have tried to exercise a graphical and reliable approach to estimate reserve. Production data, well data, fluid properties, formation properties were used for this task. It has been found that, total Gas Initially In Place (GIIP) is about 1.63 Tcf among which about 1.3 Tcf is recoverable with a recovery percentage of 80. In addition, total remaining reserve is calculated to be about 773 Bcf. All seven wells of Rashidpur Gas Field are estimated individually and summed up. The full study is a software approach and several typecurves have been exercised using a software "FEKETE F.A.S.T. RTA^{TM}. Since all the typecurves have showed approximately same result, we can be certain about the accuracy our estimation.

KEYWORDS: Reservoir, Exploration, Production, Volumetric calculation, Remaining reserve.

1 INTRODUCTION

There have been many conventional methods available for calculating oil or gas reserve. Reservoir engineers generally use material balance equations, volumetric calculations, reservoir simulation and typecurve analysis as the main tools to estimate reserve. Among these techniques, typecurve analysis, a rigorous method to interpret production and pressure data, has been found quite accurate in absence of some known reservoir parameters. So type curve is used to fulfill the objectives of this research.

The objectives related to the estimation of individual well's reserve are:

- Calculating Gas Initially In Place (GIIP/OGIP) within the areal extent of each well
- Finding Ultimate Expected Recovery (EUR) of each well
- Calculating remaining reserve (RR) that can be recovered from each well.

Following assumptions have been made for this work:

- Homogeneous isotropic reservoir
- Uniform formation thickness for each sand
- Constant porosity and compressibility
- No change of fluid properties with pressure and time.

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2 STUDY AREA

Rashidpur Gas Field, a matured, on production gas field located at Bahubal Upazila, Sylhet, Bangladesh, was found suitable with more available data and has been selected for this research. It is one of the four largest gas fields of Bangladesh discovered in 1960 by Pak Shell Oil Company Limited [4].

2.1 BACKGROUND

In one estimation, "National Committee for Gas Demand and Reserve" mentioned that, the Gas Initially In Place in Rashidpur Gas Field was 2000 Bcf among which 1460 Bcf was recoverable with a recovery percentage of 73 [3].

Before this estimation, Intercomp-Kanata Management Ltd (IKM) and Hydrocarbon Unit Bangladesh (HCU)/Norwegian Petroleum Directorate (NPD) made an estimation, which is shown in **Table-1**.

Table 1. Reserve estimation made by IKM & HCU/NPD [3]

Rashidpur Gas Field	GIIP (Bcf)	Recovery (%)	Recoverable Reserve, 2P (Bcf)
IKM(1992)	2242	58	1309
HCU/NPD (2001)	2002	70	1401

3 MATERIALS AND METHODS

3.1 DATA COLLECTION AND TREATMENT

All the data for this study were collected from "Sylhet Gas Field Limited" (SGFL) through Petrobangla. Collected data includes production data, well data, reservoir data, PVT data and some annual reports of SGFL.

FEKETE "RTA" software has been used for this analysis. Production data entered into FEKETE "RTA" seemed to be very scattered. It was required to be filtered. The objectives of data filtering were to minimize error and to obtain a good match to typecurves. So, to remove data noise and to reduce scattered data, data were filtered using type curve data filter.

After filtering it has been seen that some of the points have disappeared and the trend of the early time data is less scattered. Finally all the necessary data were entered into FEKETE "RTA" to perform the analysis.

3.2 ANALYSIS METHODS

Blasingame, Agarwal-Gardner and Normalized Pressure Integral (NPI) typecurve Analysis have been used for this work. Fetkovich analysis could not be used as we can't match the data since Fetkovich analysis assumes that production occurs under constant bottom hole flowing pressure condition.

3.3 METHODOLOGY

In Blasingame analysis, normalized rate, rate integral, and rate integral derivative are plotted vs. material balance time. In Agarwal-Gardner analysis, normalized rate and inverse semi-log derivative data are plotted against material-balance time and Normalized pressure, pressure integral, and pressure integral derivative are plotted vs. material-balance time in case of Normalized Pressure Integral analysis. All the data are plotted on a log-log scale of the same size as the type curves. This plot is called the "data plot". The data plot was moved over the type curve plot, while the axes of the two plots were kept parallel, until a good match was obtained [1][2][6]. Several different type curves have been tried to obtain the best fit of all the data. The type curve, that best fits the data, is selected. Gas Initially In Place (GIIP/OGIP) is directly calculated from the type-curve match.

4 RESULTS & DISCUSSIONS

4.1 RESULTS

In this section the results of this individual type curve analysis is presented and discussed. Results, found by each analysis are close enough, however to get a better result, we have averaged the results of these methods. Total cumulative production G_p is 532.538 Bcf [4]. Remaining recoverable reserve is calculated to be 861.57 Bcf using the following equation -

$$RR_{total} = EUR_{total} - G_p$$

The results of each analysis methods are given in **Table-2**. Figures are shown in **Appendix-A**

Table 2. Results of different type curve analysis methods

Analysis methods→		Blasingame	Agarwal-Gardner	Normalized Pressure Integral(NPI)	Average value
Name of well ↓	Results (Bcf)				
Rashidpur 01	GIIP	665.451	667.017	669.779	667.42
	EUR	532.360	533.613	535.823	533.93
Rashidpur 02	GIIP	184.280	182.051	180.553	182.29
	EUR	147.424	145.641	144.442	145.84
Rashidpur 03	GIIP	231.144	227.152	230.789	229.7
	EUR	184.915	181.721	184.631	183.76
Rashidpur 04	GIIP	291.875	289.305	292.803	291.33
	EUR	233.500	231.444	234.242	233.062
Rashidpur 05	GIIP	73.036	72.840	73.474	73.12
	EUR	58.429	58.272	58.779	58.49
Rashidpur 06	GIIP	21.904	21.488	21.949	21.78
	EUR	17.523	17.190	17.559	17.424
Rashidpur 07	GIIP	165.400	166.847	166.147	166.13
	EUR	132.320	133.478	132.918	132.91

- Total Gas Initially In Place (GIIP, Average value) : 1631.77 (Bcf)
- Total Ultimate Expected Recovery (EUR, Average value) : 1305.41(Bcf)
- Total Remaining Reserve (RR, Average value) : 772.87 (Bcf)

4.2 DISCUSSIONS

The estimated GIIP of this work is compared with the previous estimation made by HCU/NPD as shown in **Table -3**

Table-3: comparison between the estimation made by HCU/NPD and this analysis.

Reserve estimation made by-	GIIP (Bcf)	Recovery %	EUR (Bcf)
HCU/NPD (2001)	2002	70	1401
This work	1631.77	80	1305.41

Table-3 shows a difference of about 370.23 Bcf in GIIP between these two analyses. Since reserve can be categorized as developed reserve, which is expected to be recovered from the existing wells and undeveloped reserve, which is expected to be recovered from new wells on undrilled acreage; this difference can be considered undeveloped reserve [5]. However, the comparatively higher recoverable reserve of our research is the result of higher recovery percentage.

Total developed reserve from the seven wells is found to be 1.631 Tcf. Comparing to the initially estimated 2.002 Tcf by HCU/NPD; more wells should be drilled to extract the undeveloped reserve.

5 FIGURES

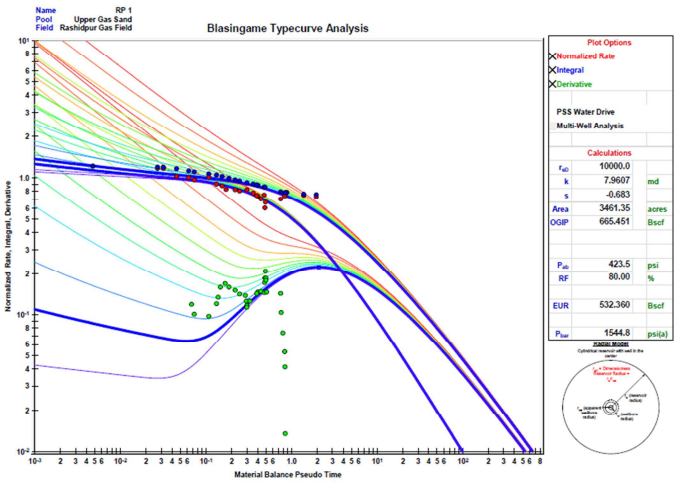

Figure-1: Reserve estimation of Rashidpur-1 well using Blasingame type curve

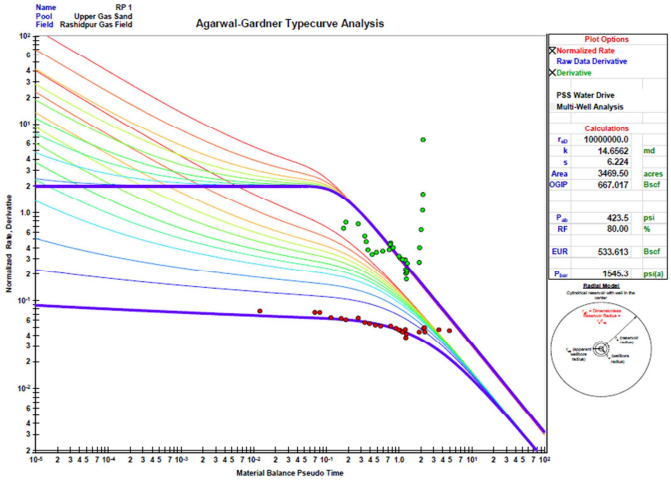

Figure-2: Reserve estimation of Rashidpur-1 well using Agarwal-Gardner type curve

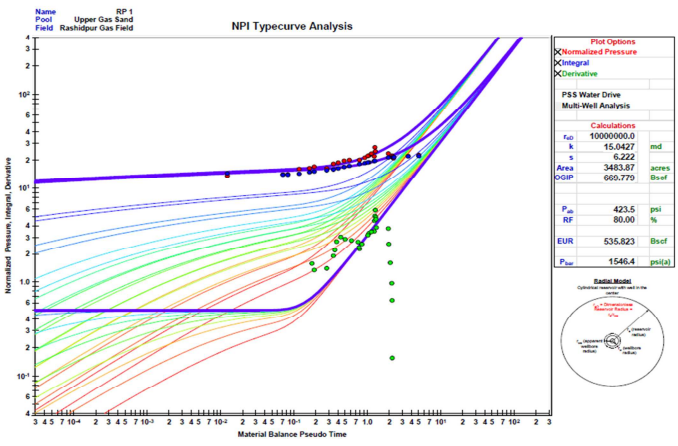

Figure-3: Reserve estimation of Rashidpur-1 well using NPI type curve

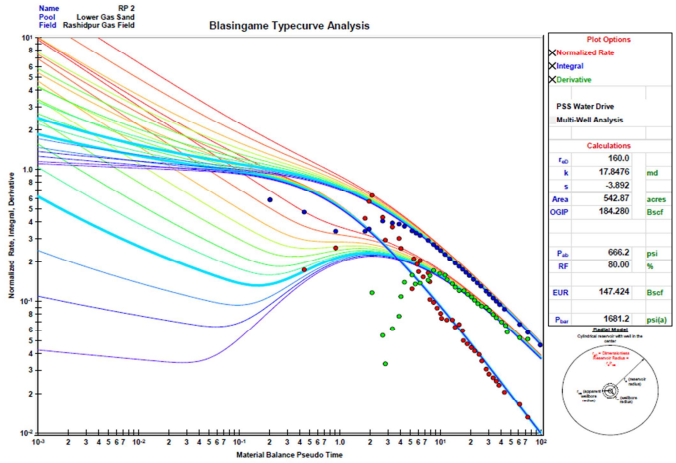

Figure-4: Reserve estimation of Rashidpur-2 well using Blasingame type curve

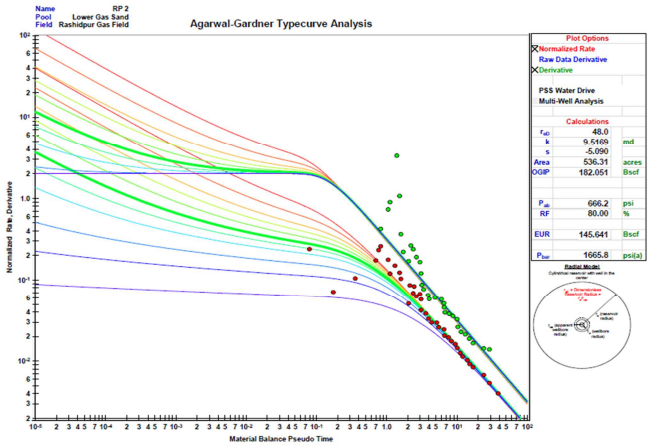

Figure-5: Reserve estimation of Rashidpur-2 well using Agarwal-Gardner type curve

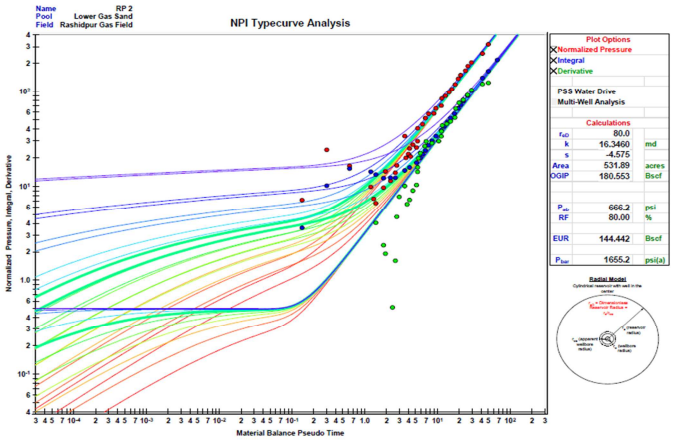

Figure-6: Reserve estimation of Rashidpur-2 well using NPI type curve

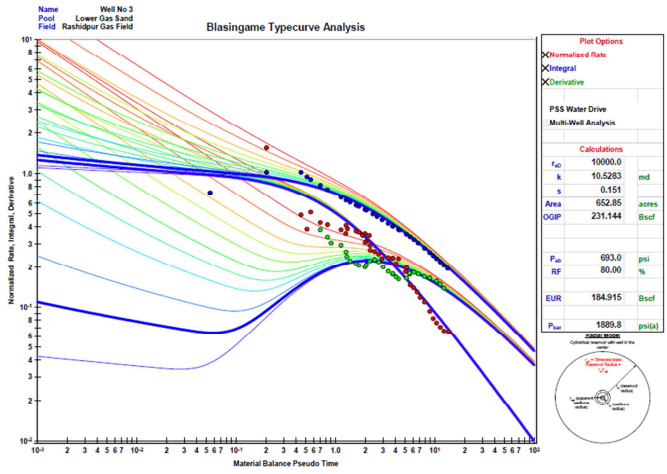

Figure-7: Reserve estimation of Rashidpur-3 well using Blasingame type curve

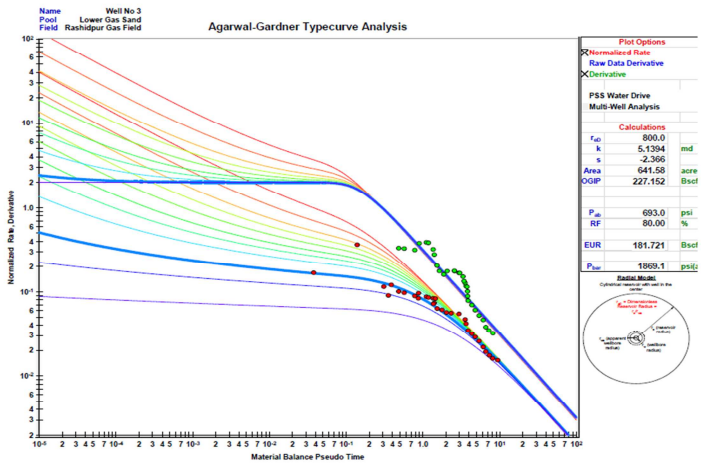

Figure-8: Reserve estimation of Rashidpur-3 well using Agarwal-Gardner type curve

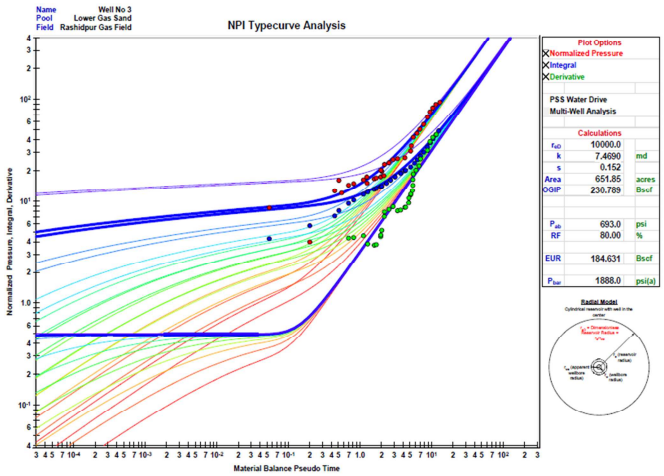

Figure-9: Reserve estimation of Rashidpur-3 well using NPI type curve

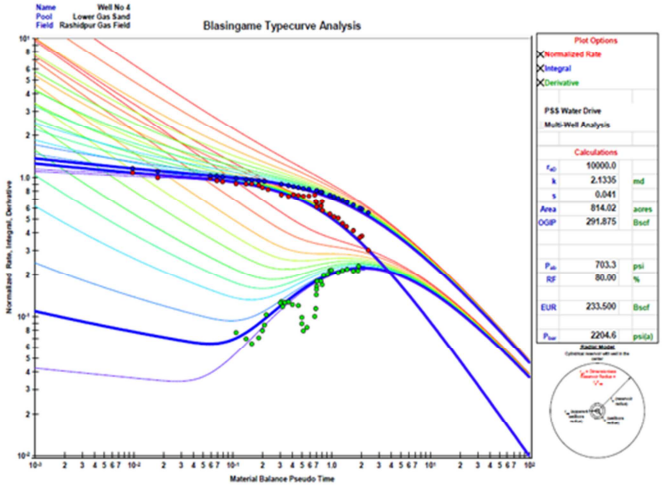

Figure-10: Reserve estimation of Rashidpur-4 well using Blasingame type curve

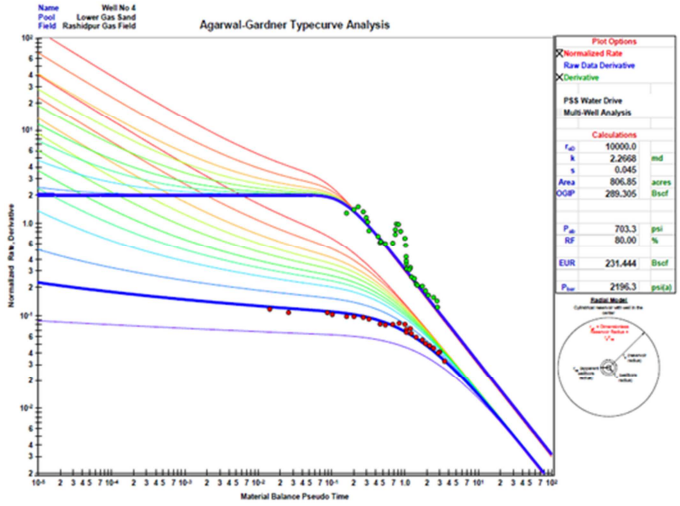

Figure-11: Reserve estimation of Rashidpur-4 well using Agarwal-Gardner type curve

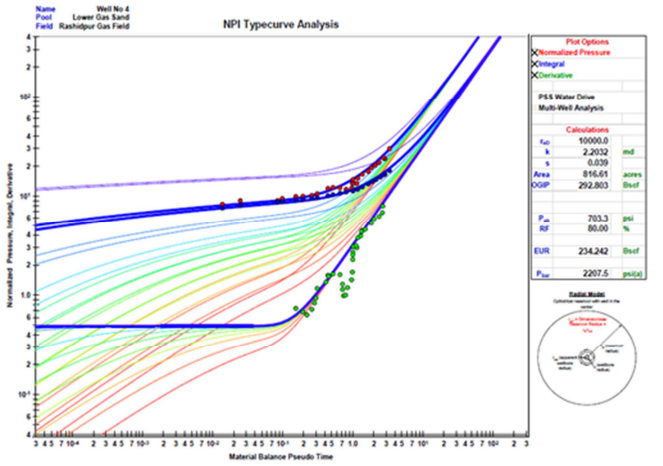

Figure-12: Reserve estimation of Rashidpur-4 well using NPI type curve

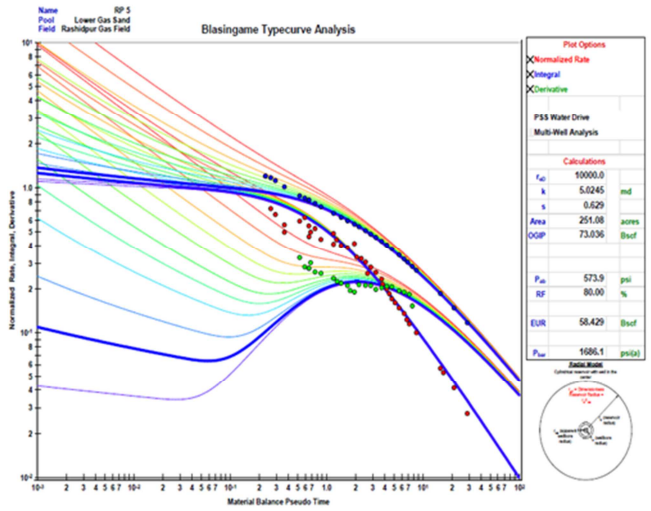

Figure-13: Reserve estimation of Rashidpur-5 well using Blasingame type curve

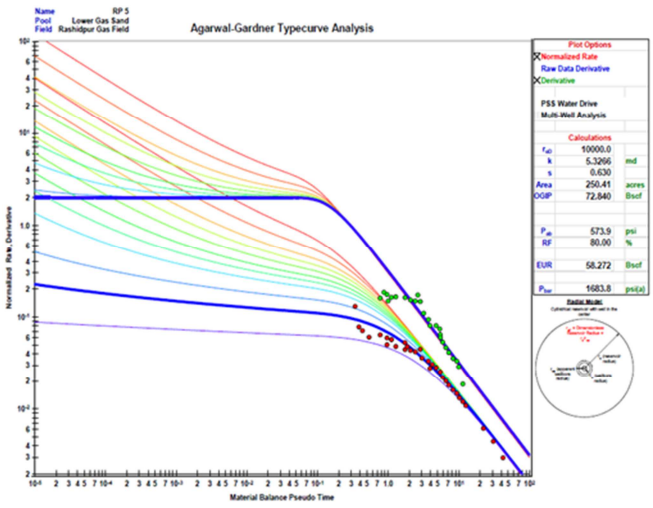

Figure-14: Reserve estimation of Rashidpur-5 well using Agarwal-Gardner type curve

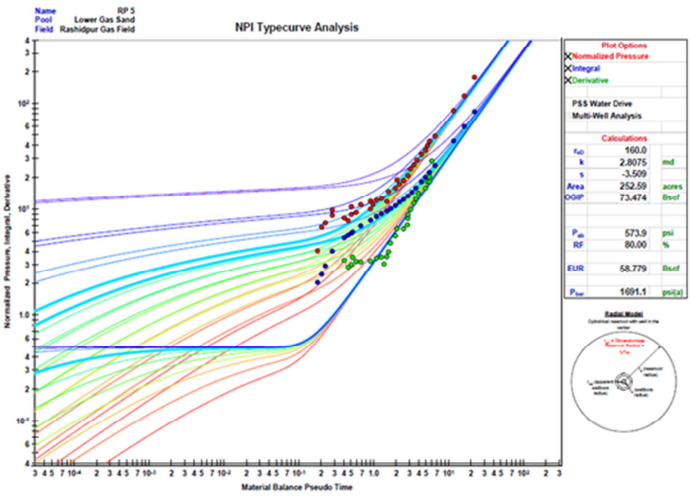

Figure-15: Reserve estimation of Rashidpur-5 well using NPI type curve

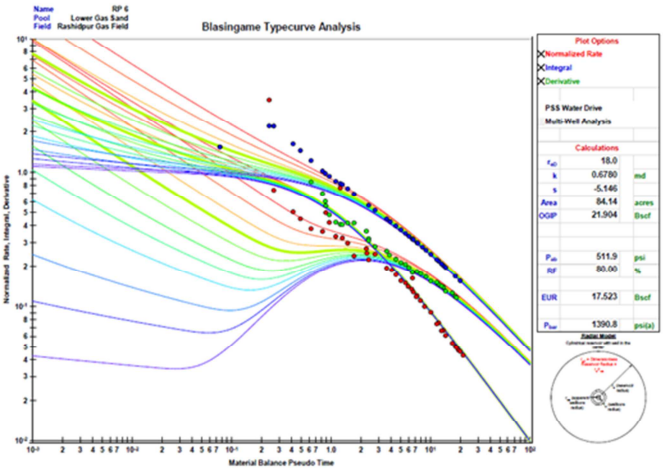

Figure-16: Reserve estimation of Rashidpur-6 well using Blasingame type curve

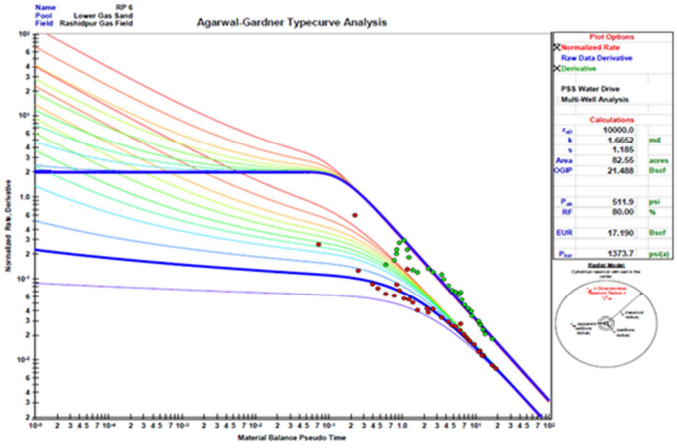

Figure-17: Reserve estimation of Rashidpur-6 well using Agarwal-Gardner type curve

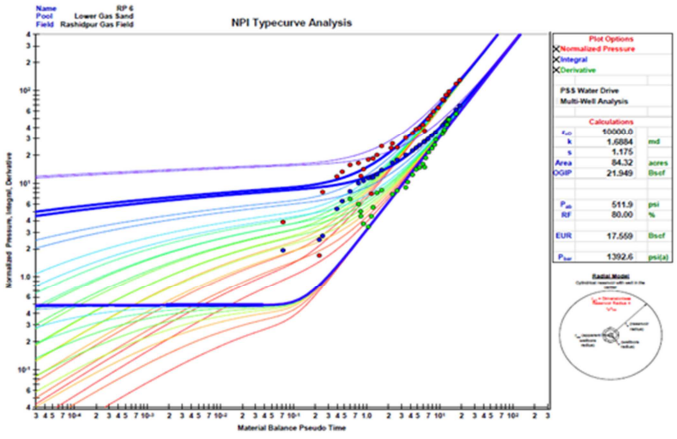

Figure-18: Reserve estimation of Rashidpur-6 well using NPI type curve

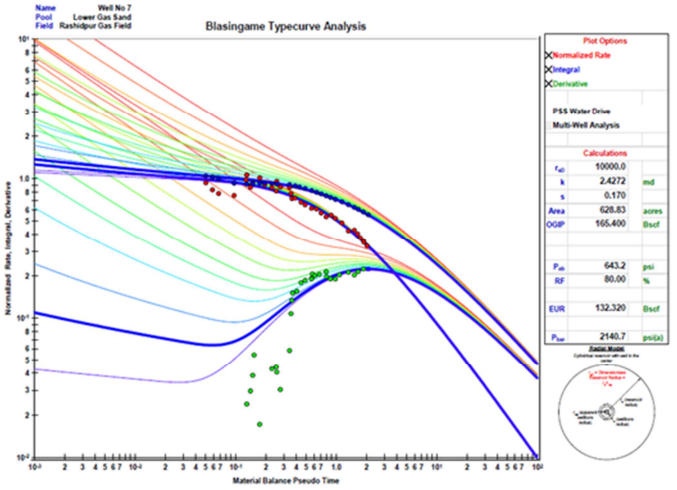

Figure-19: Reserve estimation of Rashidpur-7 well using Blasingame type curve

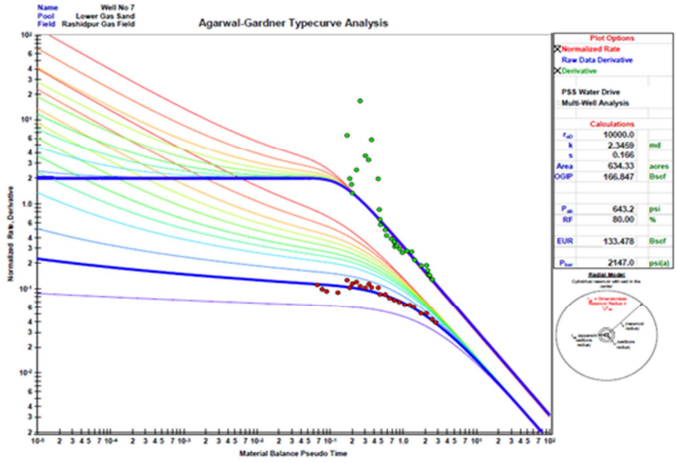

Figure-20: Reserve estimation of Rashidpur-7 well using Agarwal-Gardner type curve

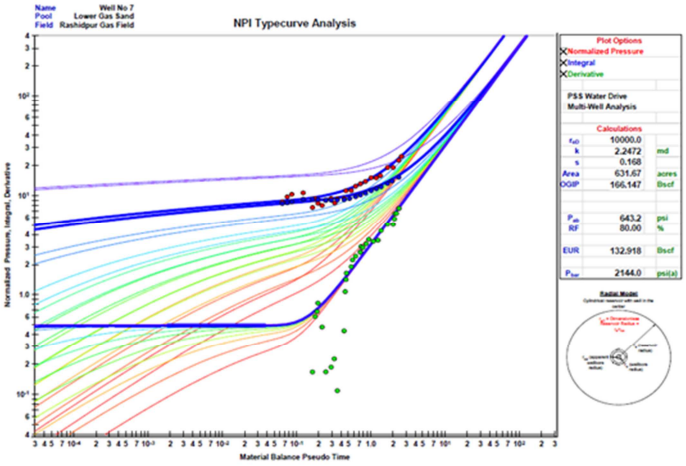

Figure-21: Reserve estimation of Rashidpur-7 well using NPI type curve

6 CONCLUSION

Reserve may change with time due to the migration and accumulation of gas. So reserve estimation is a dynamic activity conducted when more accurate data are available with the development of the field. The approximately same result of all the typecurves is an indication of reliable estimation.

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