

Central Petroleum
CBM 107-002 Well
Purni Formation
Perdika Basin
May 2010
Water Injection-Falloff Test Analysis Summary

Prepared by:
Yi Wang
Weatherford Laboratories

May 11, 2010

Table of Contents

Table of Contents i
 List of Tables i
 List of Figures i
 Summary 1
 Test Analysis Details 2
 References 6

List of Tables

Table 1. CBM 107-002 Pressure and Temperature Conditions 1
 Table 2. CBM 107-002 Reservoir Property Summary 1
 Table 3. Injection-Falloff Test Times 3
 Table 4. Analysis Parameters 4
 Table 5. Test Analysis Results 4

List of Figures

Figure 1. Pressure and Temperature Data 2
 Figure 2. Surface Water Injection Rate Data 3
 Figure 3. Falloff Period Diagnostic Graph 5
 Figure 4. Falloff Period Semilog Graph 5
 Figure 5. History Match 6

Summary

Weatherford Laboratories (WFT Labs) conducted one water injection-falloff tests between May 10th, 2010 and May 11th, 2010, of Purni Formation penetrated by Central Petroleum's CBM 107-002 well. However, one valve failed shortly after the falloff started, which interrupted the normal pressure drop. The test was stopped earlier than planned. The data obtained after the valve failure should be excluded from the analysis. Therefore, the confidence of analysis results was low due to the limited quality of quantity of pressure data. All results presented in this summary shouldn't be regarded as conclusive unless they were validated by data from other resources, e.g. core analysis and production data. Table 1 summarizes the pressure and temperature conditions of tested interval. Table 2 summarizes the test analysis results.

This well is a core hole that was not produced before testing and the coal natural fracture (cleat) systems were water filled during each test. Therefore, estimates of permeability to water were equivalent to the absolute permeability.

Table 1. CBM 107-002 Pressure and Temperature Conditions

Test Interval	Coal Top Depth	Coal Bottom Depth	Static Pressure	Pressure Depth	Pressure Gradient*	Temperature	Temperature Gradient**
	m	m	kPaa	m	kPa/m	°C	°C/m
Purni Formation	306	318	3,799	308	12.0	38.4	0.0435

* Pressure gradient computed with a surface pressure of 101.325 kPaa.

** Temperature gradient computed with a mean annual surface temperature of 25 °C.

Table 2. CBM 107-002 Reservoir Property Summary

Test Interval	Coal Thickness	Effective Conductivity to Water	Effective Permeability to Water	Skin Factor
	m	md-m	md	-
Purni Formation	12	14.4	1.2	-1.06

The test was evaluated with a constant permeability model with infinite boundary condition. The permeability estimate of 1.2 md was moderate. The estimated skin factor of -1.06 suggests that a stimulated near-well area with higher permeability than the reservoir.

The remainder of this report discusses the test data and the analysis thereof.

Test Analysis Details

The water injection-falloff test was performed between May 10th, 2010 and May 11th, 2010. The test interval was Purni Formation at depths between 306 and 318 m. This section discusses the analysis of the data collected during this test.

Figure 1 illustrates pressure and temperature measured by a transducer at a depth of 308.2 m. The test consisted of an 8-hour injection period at an average rate of 1.20 liters per minute that started approximately 7 hours after the transducers were initialized followed by a 10-hour falloff period with no injection.

Figure 1. Pressure and Temperature Data

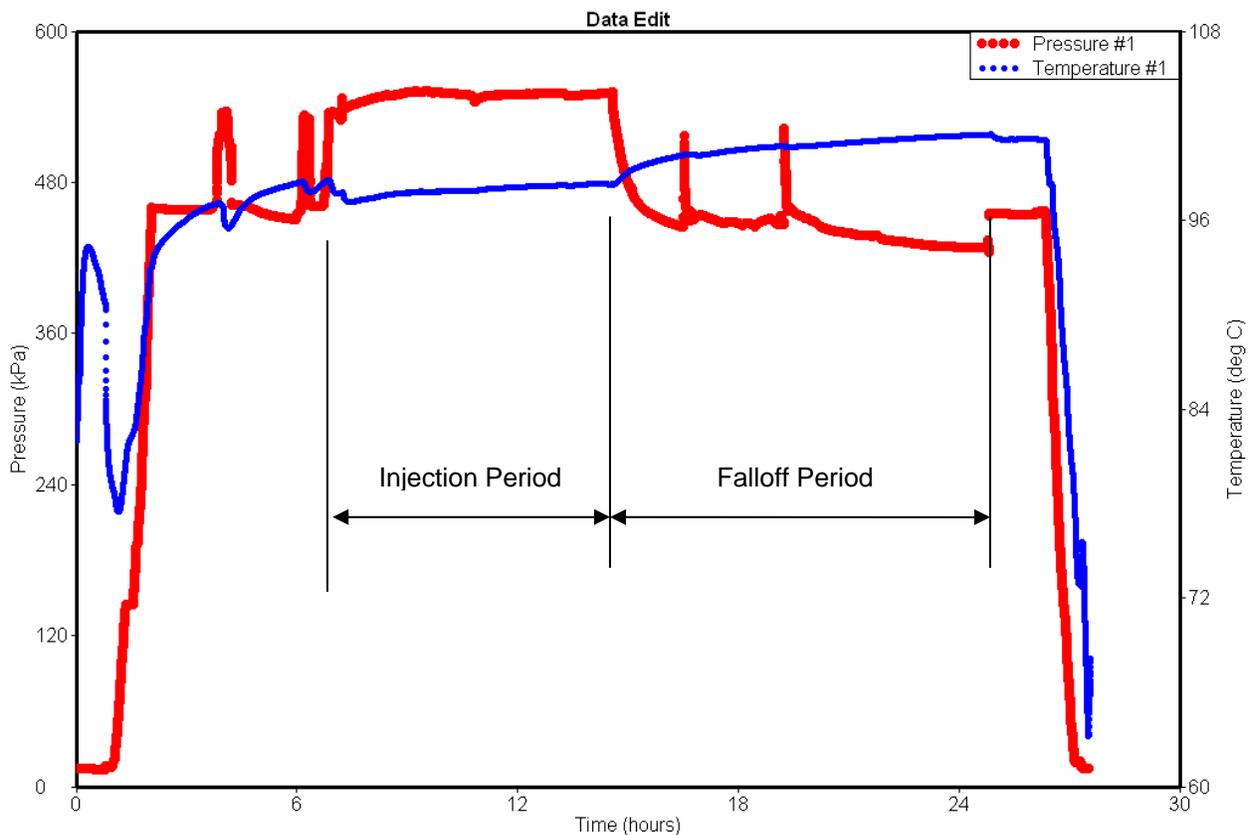


Figure 2 illustrates the surface water injection rate data. The injection rate data were simplified to the test history summarized in Table 3 for analysis.

Figure 2. Surface Water Injection Rate Data

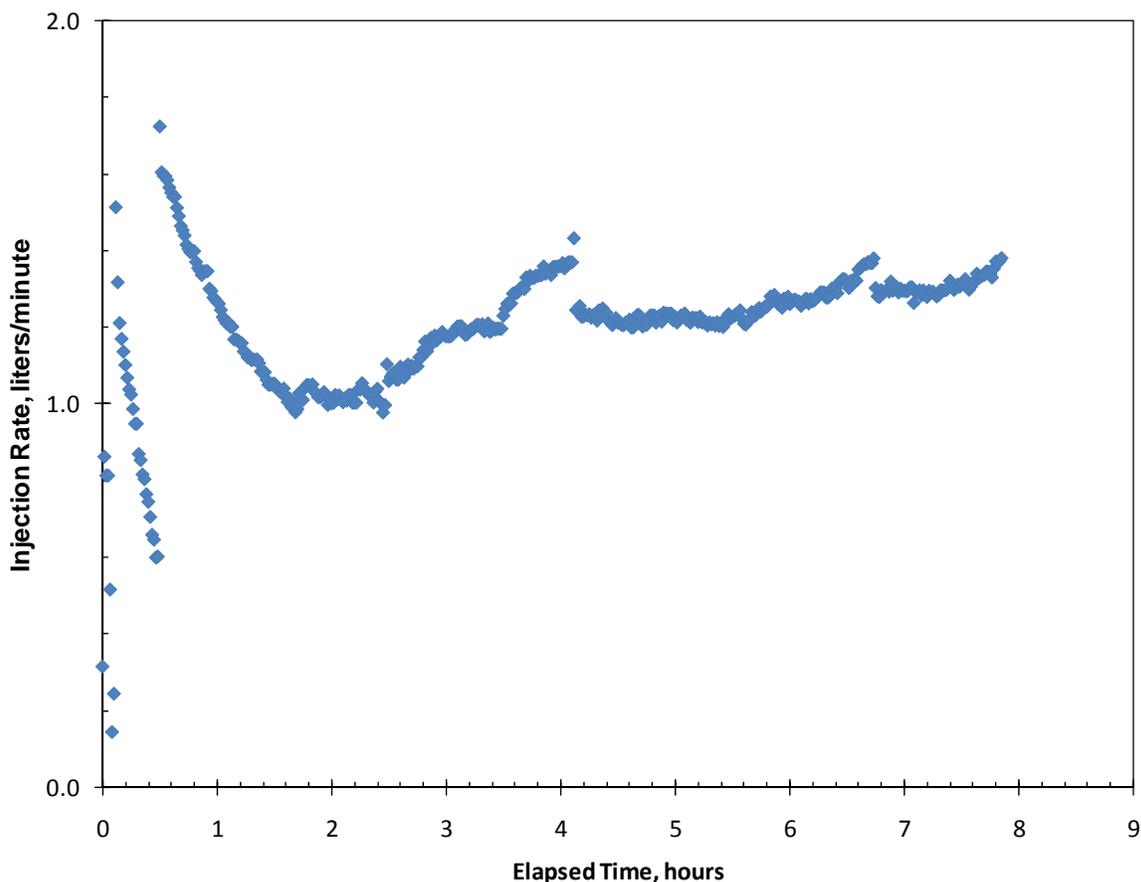


Table 3. Injection-Falloff Test Times

Test Period	Elapsed Time at Period Start	Elapsed Time at Period End	Surface Water Injection Rate	Pressure at Period Start	Pressure at Period End
	hours	hours	liters/min	kPaa	kPaa
Injection	0.000	7.851	1.2	3,173.6	3,798.9
Falloff	7.851	18.046	0	3,798.9	2,948.5

Table 4 summarizes the test analysis parameters. The coal thickness was determined by visual observation of the coal during coring activities. Water properties were estimated from correlations¹ for fresh water at the reservoir temperature.

Table 4. Analysis Parameters

Parameter	Units	Value
Geometry		
Top Depth	m	306.0
Bottom Depth	m	318.0
Coal Thickness	m	12.0
Wellbore Radius	m	0.089
Coal Matrix Properties		
Temperature	°C	38.4
Natural Fracture Properties		
Porosity	vol. fraction	0.01
Total Compressibility	kPa ⁻¹	1.83(10 ⁻⁶)
Water Properties		
Viscosity	cp	0.680
Formation Volume Factor	res. vol./surface vol.	1.005

Table 5 summarizes the analysis results that resulted from matching the infinite model to the observed test behavior. The computed behavior generally matched the measured data throughout the test.

Table 5. Test Analysis Results

Property	Unit	Value
Model	-	Infinite reservoir
Static Pressure	kPaa	3,799
Temperature	°C	38.4
Pressure and Temperature Depth	m	308.2
Pressure Gradient to Surface	kPa/m	12.0
Temperature Gradient to Surface	°C/m	0.0435
Effective Conductivity to Water	md-m	14.4
Effective Permeability to Water	Md	1.2
Wellbore Storage Coefficient	m ³ /kPa	2.52(10 ⁻⁵)
Skin Factor	-	-1.06

Figure 3 illustrates a diagnostic graph of the falloff period data. A diagnostic graph presents the log of the pressure change and the log of the derivative of the pressure change versus the log of the elapsed time during the period.

The data were evaluated with an infinite reservoir model. The model matched the falloff period well as illustrated in Figure 3, which is a semilog graph of the falloff period data. Figure 4 illustrates the match with entire testing history.

Figure 3. Falloff Period Diagnostic Graph

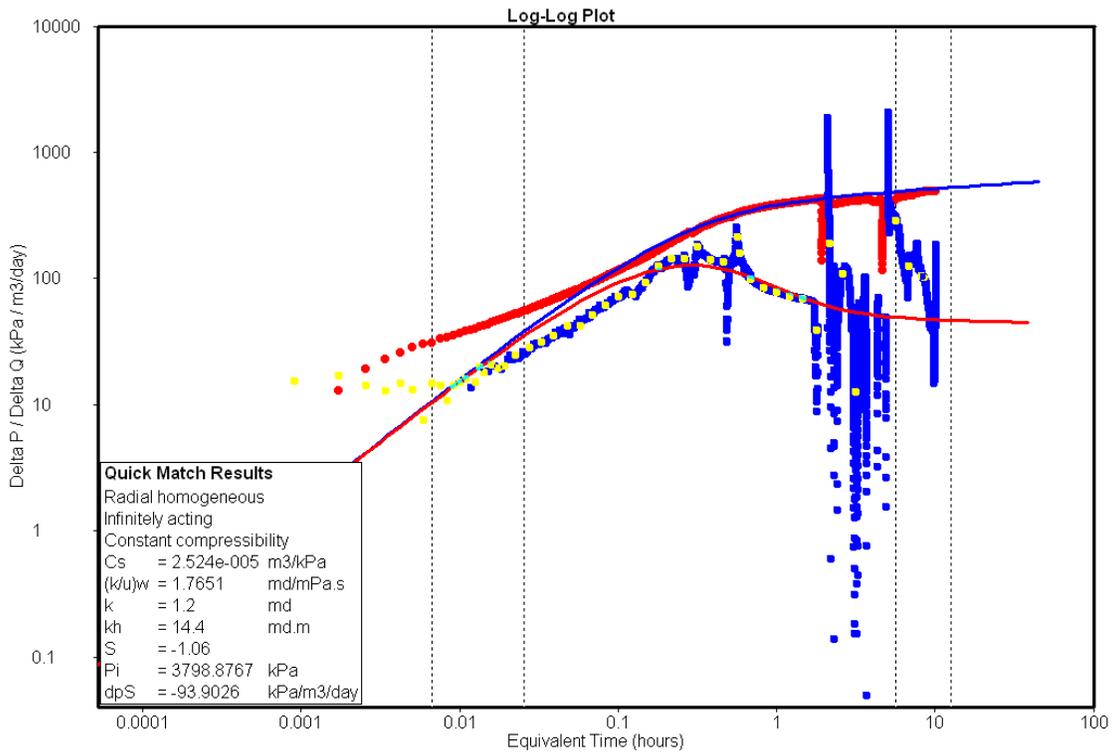


Figure 4. Falloff Period Semilog Graph

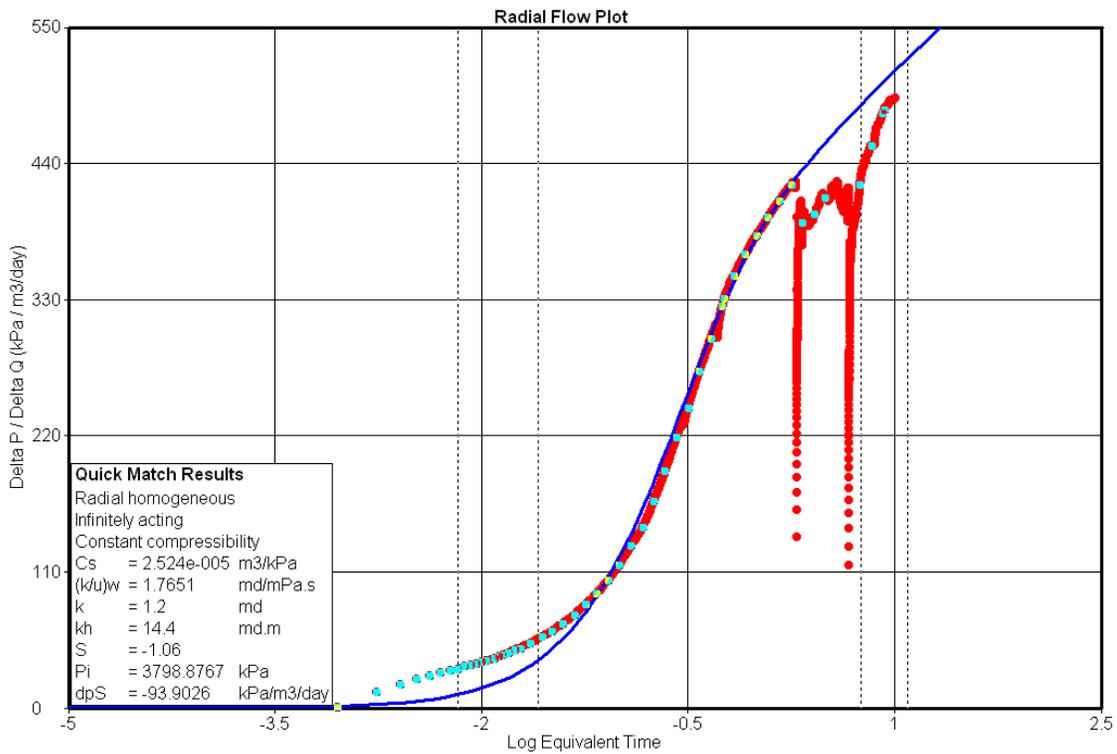
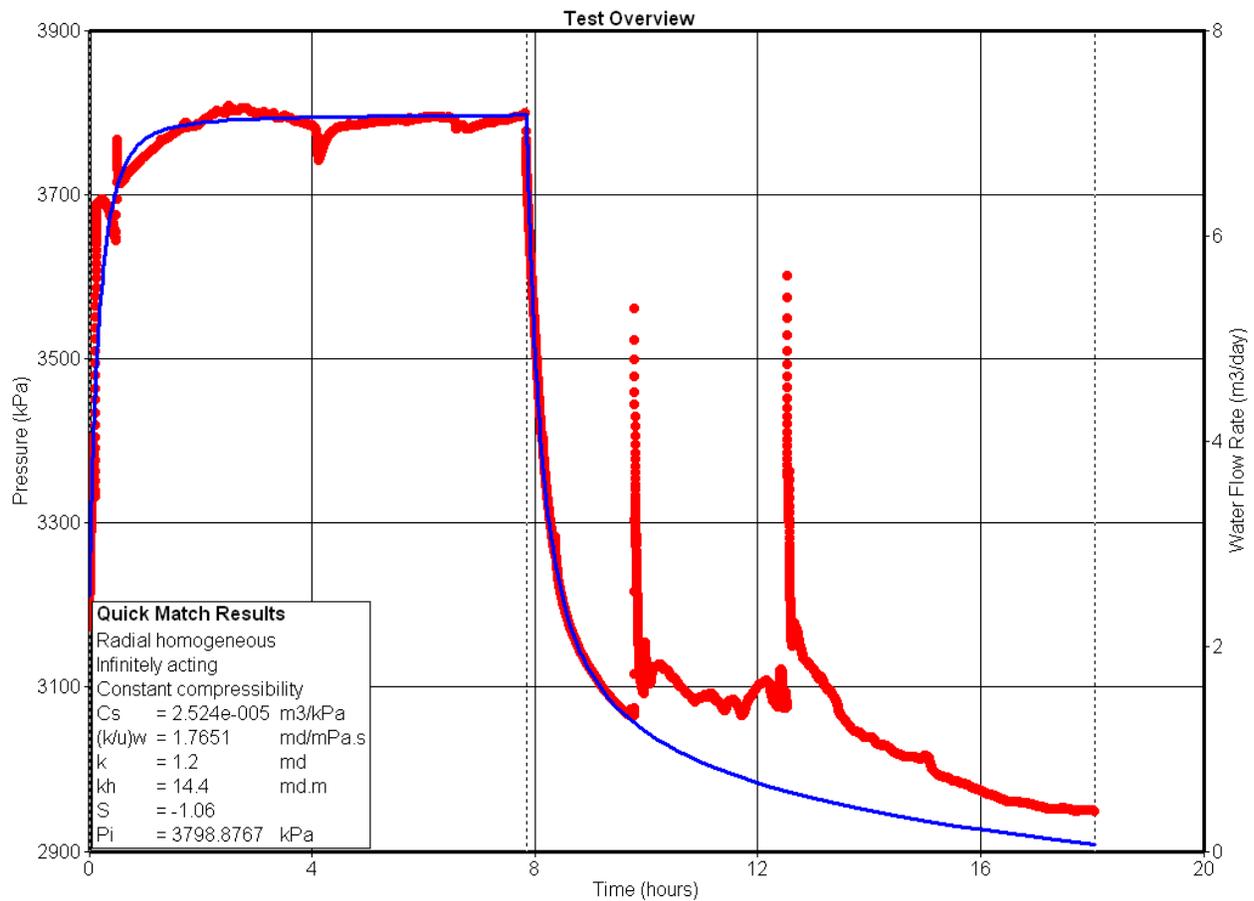


Figure 5. History Match



The pressure behavior at the beginning of falloff period is strongly affected by wellbore storage and skin factor. On the contrary, initial reservoir pressure and permeability were highly correlated to the pressure behavior at the end of falloff period. Since the falloff period was too short in this case, which ideally should be around 16 hours, the confidence in the initial reservoir pressure and permeability was lower than that of wellbore storage and skin factors. All results should be verified before being applied as basis of any future analysis.

References

1. Whitson, C.H., and Brule, M.R.: *Phase Behavior*, Monograph Volume 20, Henry L. Doherty Series, Society of Petroleum Engineers, Richardson, Texas (2000).