15-185-20807 5-23s-12w

Evaluation

of the

Drawdown/Buildup Test

on the

Hitz #1

Section 5-23S-12W
Stafford Co., Kansas
Prepared for

Parrish Corporation

March 30, 2001

Integrated
Solutions
For the Energy Industry

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March 30, 2001

Lloyd Parrish
Parrish Corporation
110 S. Main
Suite 510
Wichita, Kansas 67202

Dear Lloyd:

I have competed my analysis of the buildup test on the Hitz #1 Sec 5-23W-12W Stafford County Kansas. The headings below correspond to a figure or plot with the same name contained in the back pocket of the folder

Prior Production

The completion report from Martin Oil Producers dated from 1/14/86 thru 1/22/86 commented that the well had produced 8 hours/day for 5 days. Based on this information I estimate that the cumulative production at this time was 2.33 MMcf. Because of the uncertainty of this data, and the small amount of total production I did not consider this amount of production material to the overall evaluation, therefore it was not included in the analysis.

Strip Chart

This plot shows the pressure and flow rates recorded during the test. The most alarming observation is the irregularity of the flowing pressure data. In a dry gas well it is anticipated that the flowing pressure will decrease during the test in a uniform manner. In this case the pressures not only increased, but did so in a erratic fashion.

The most likely explanation for this behavior is "liquid loading". Because the well did not have tubing the velocity of the gas was not high enough to unload all of the condensate that the well was producing. A fluid column was established during the flowing portion of the test.

The page titled "FieldNotes Field Measurement" shows the casing pressure during the test. In comparing these pressures with those seen on the "Strip Chart" it may be seen that a column, with about 600 psi of hydrostatic head is present towards the end of the flow period. My calculations show that in order to keep the well unloaded the flowrate would need to be 1.5 MMcfd or more.

DERIVATIVE ANALYSIS

This plot presents the buildup data in three formats. The first curve I look at is the PPD curve. The utility of this curve is in determining whether the data represents only "reservoir" data or if "non-reservoir" effects have influenced it. The non-reservoir effects are things such as well bore storage and phase segregation. Phase segregation is most commonly thought of as fluid loading.

In a reservoir showing only reservoir behavior, each point on the PPD curve will be lower than the preceding point. From the start of the shut-in until the first red arrow, this is indeed what is seen. However from the first red arrow to the second, the PPD curve shows very erratic behavior. This tells us that the reservoir is not responsible for the irregularities, and more importantly that the data cannot be interpreted. After the second arrow the data returns to reservoir type behavior.

The green circles represent the rate of change of pressure. The red stars are the derivative of the first curve. This is the curve most often used in quantitative interpretations. Unfortunately due to the extreme effects of the phase segregation this data is not interpretable. I have superimposed a Radial Flow line on the curve in order to provide an estimate of the permeability, skin and p* calculated. These values are shown in the box titled "Radial 0".

Composite Model

In an effort to analyze the data I constructed several mathematical models of the reservoir and wellbore. A composite model provided the best fit to the buildup data. A composite model assumes two regimes surrounding the wellbore. Each area has separate reservoir characteristics, the most important of which is permeability. It can be visualized as two concentric rings around the wellbore, each with its own reservoir properties.

This page shows the results of the fit in four different presentations. The upper left plot is the old "type curve" presentation. Computers have superceded this type of analysis, so I have included it for informational purposes only. What is important on this plot, however is legend.

The legend shows the model results on three critical parameters, Pi, p* and GIP. Pi is the calculated initial pressure of the reservoir. This value should correlate with the pressure recorded during the static fluid level survey. The survey and the calculation both show 1265 psi as the original reservoir pressure.

P* is the pressure that the well would build up to if left shut-in for an unlimited period of time. In this case it calculates to be about 1262 psi. Although this appears to indicate that the reservoir depleted by 3 psi during the test, it must be noted that this drop is not within the accuracy of the measuring tool. It is entirely possible that no measurable depletion occurred during the test.

The GIP (Gas in Place) is calculated to be about 328 MMcf. This value is based on the volumetric parameters listed on the sheet titled "Composite Gas Well Model". The test was designed to test a minimum area of 40 acres, or a radius of about 750 feet. If in the model, I lower the radius below 1000' the "goodness of fit" decreases. Based on this, the model assumes a radius of 1000'. I believe that this is the smallest reservoir volume that may be drained. It is possibly larger than this.

The lower right hand plot shows the "Derivative Analysis" mentioned in the previous section. The flattening of the build up causes the prominent downward trend at the end of the test. When this build up is extrapolated out 12 months, p* is the result. As you can see I have a fairly good fit considering the quality of the data.

The lower left-hand curve is the "Strip Chart" presented earlier with the results of the model superimposed. The model results are the red line. You can see that during the shut-in portion of the test, the fit is excellent, within 0.2% error as shown by the gray line.

During the flow period of the test the fit is unacceptable. It is rare to achieve a good fit during the flow period because the fluids are so dynamic and because there are often phase changes taking place. Although it would be nice to see a better fit in this section, it is rare.

Hitz #1 Composite Model, 72 Acres Drainage

This is a production forecast for the well. The three curves represent three separate backpressures against the well face. The data is presented in this format to help you evaluate the effectiveness of adding compression. After about 1 month the well with 500 psi of backpressure will be producing about 350 mcfd. With compression installed, and the backpressure lowered to 100 psi, the well will produce about 400 mcfd.

The next page titled "Transient Gas Forecast" is the tabular data for the plot.

Static Gradient Report

This page shows a plot of the pressure as recorded on the gauge vs. depth. The purpose of the gradient is to determine if fluid is present in the hole, what type of fluid it is and the shut-in bottom hole pressure. The calculated gradient is shown in the last column on the page. As you can see the gradient is 0.03 psi/ft all the way to TD. This gradient is consistent with a wellbore full of gas. No liquid level is apparent.

The maximum recorded pressure was 1265 psi. and the maximum temperature was 114.5 deg. F both at 3550'.

Summary

I believe that the test was properly designed and executed. Even though the fluid entering the wellbore significantly affected the data, I believe that the test accurately represents the reservoir conditions present today.

During the design phase of this test I estimated the reservoir permeability to be about 8 md. This test proved up an area away from the wellbore that measured about 7 md. The area immediately surrounding the wellbore appears to have either sustained some damage over the years or is of much poorer quality rock.

I am unable to make a determination as to whether the reservoir was damaged or if the well was simply drilled into a tight zone. I suspect that stimulation may help this well considerably.

I expect the well to make condensate as well as gas. It is likely that the well will need a pumping unit to keep the well from loading up. The well will need to make at least 350 mcfd, up 2 3/8" tubing and 100 psi backpressure, in order to keep the condensate from loading up the well.

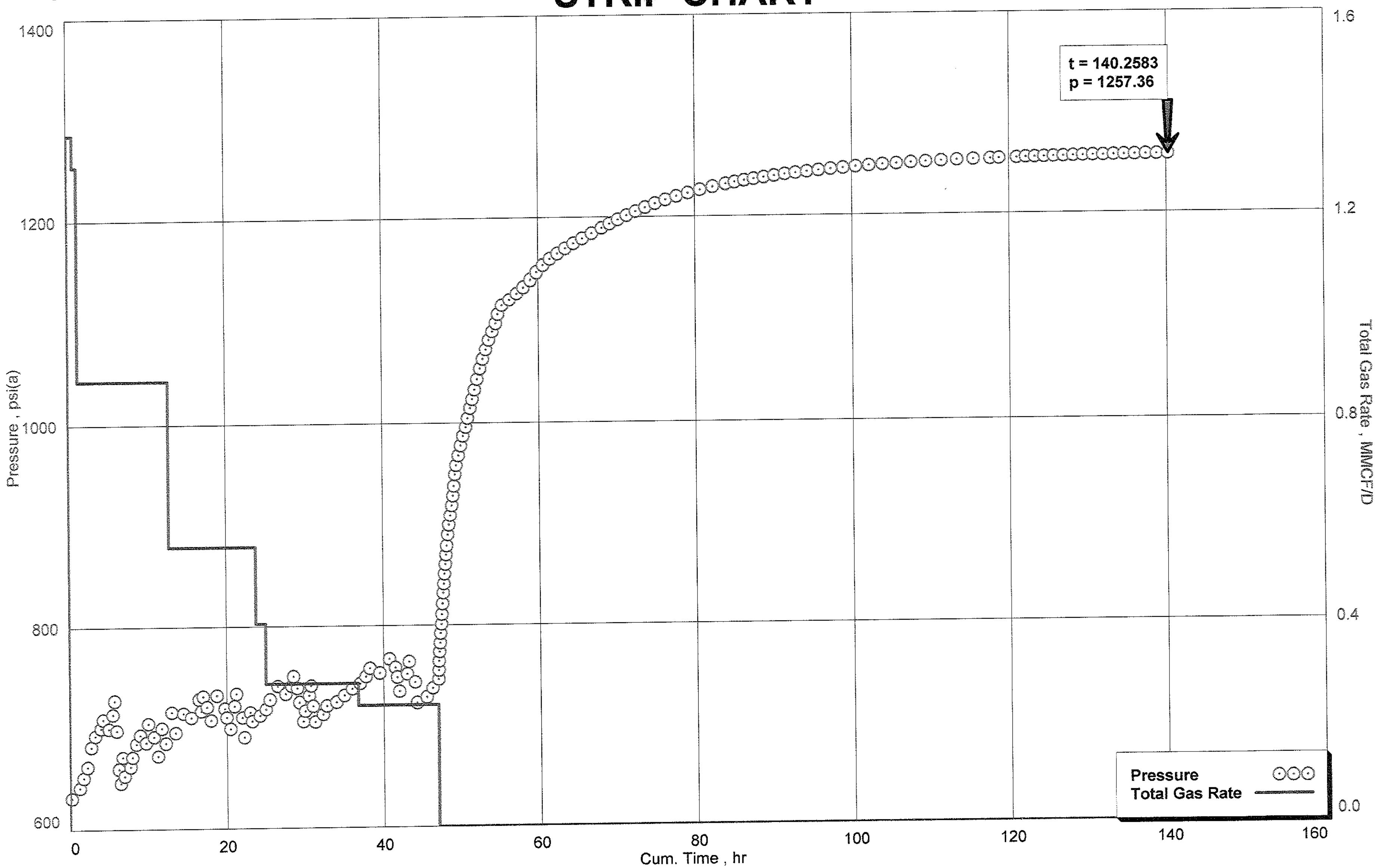
Please review this information and call with any questions.

Sincerely,

William M. Johnson
Managing Partner

Parrish Corp.
Hitz #1
Stafford Co. Ks. Sec 5-23S-12W
Lansing 3543'-3548'

STRIP CHART



Parrish Corp.
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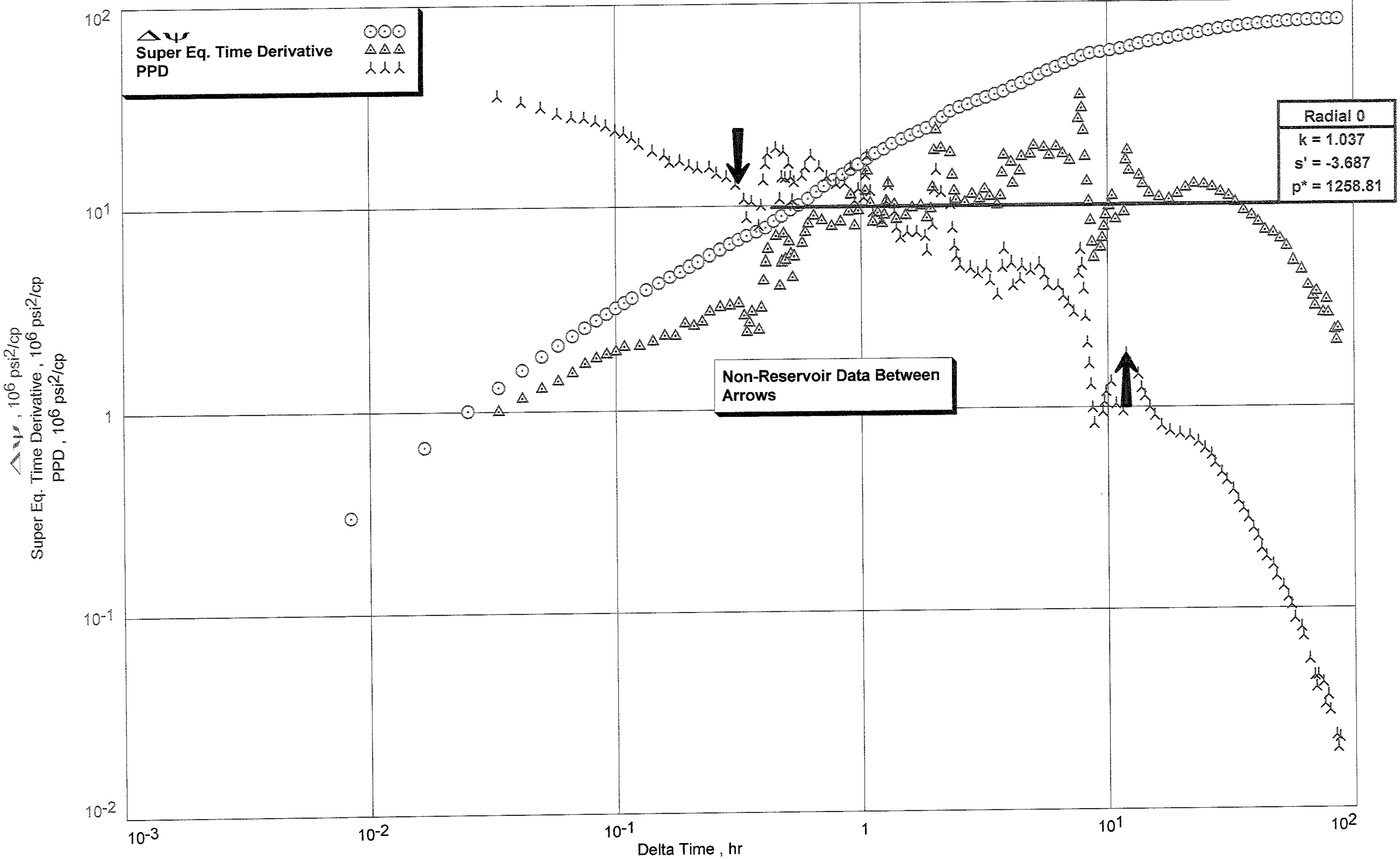
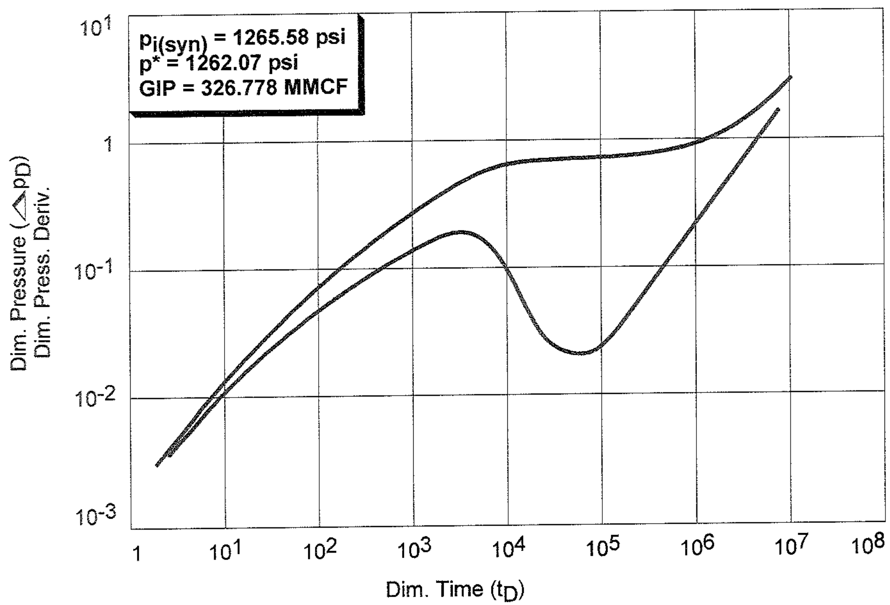
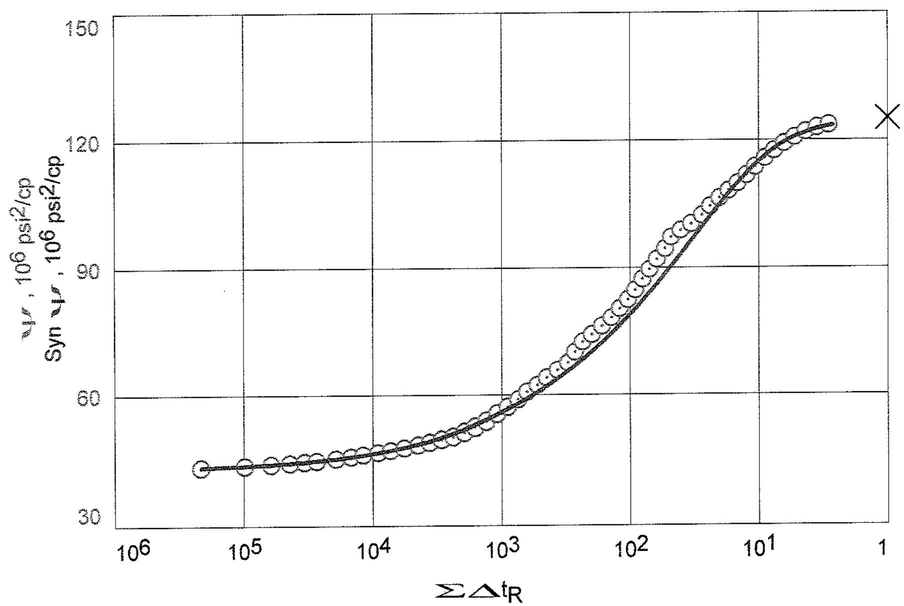
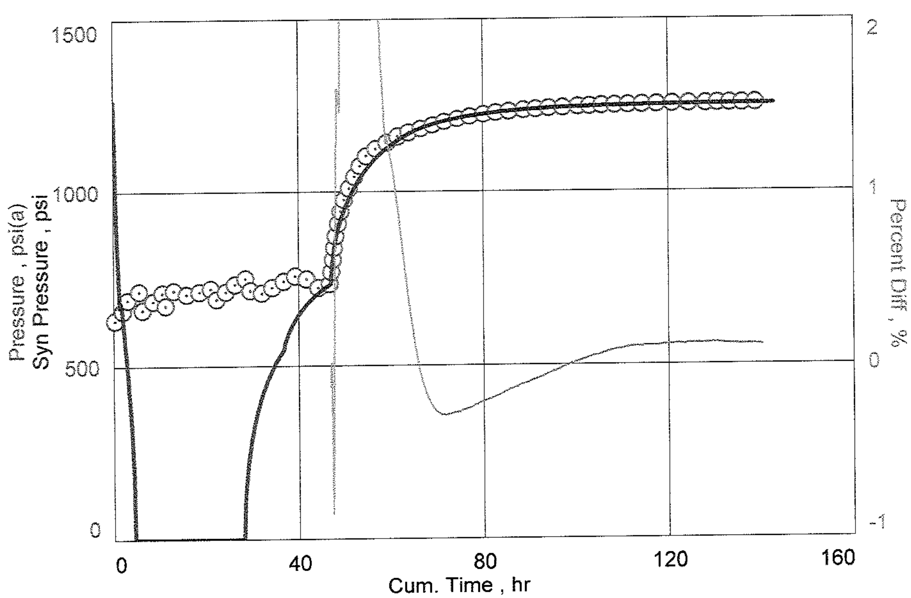
DERIVATIVE ANALYSIS

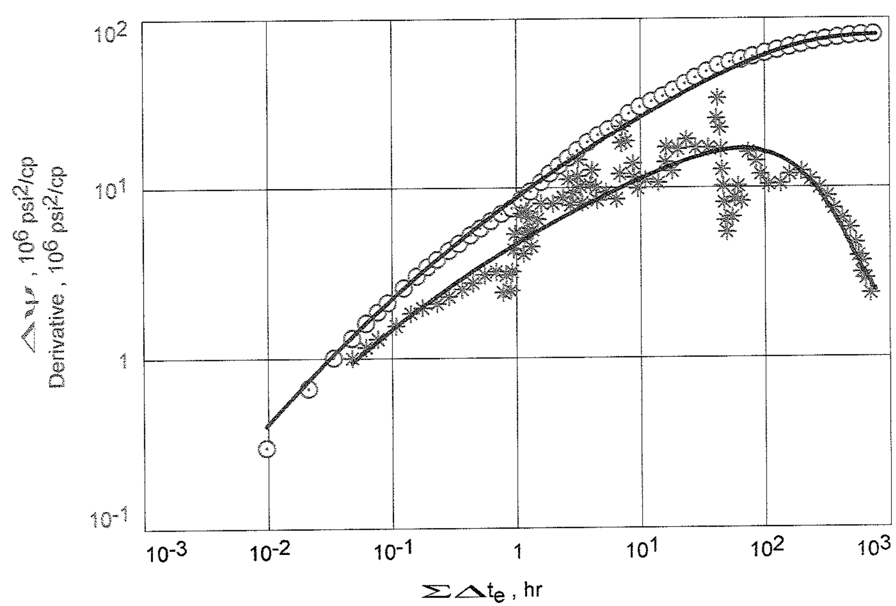


Composite Model #1









Fast

Composite Gas Well Model

Case Name : Composite Model #1

Parrish Corp.

Hitz #1

Stafford Co. Ks. Sec 5-23S-12W

Lansing 3543'-3548'

Model Parameters

		Region 1		Region 2
Permeability	$k_1=$	0.250 md	$k_2=$	7.000 md
Viscosity	$\mu_1=$	0.015 cp	$\mu_2=$	0.015 cp
Net Pay	$h_1=$	8.00 ft	$h_2=$	8.00 ft
Inter Porosity Coeff	$\lambda_1=$	1.0000e0	$\lambda_2=$	1.0000e0
Storativity Ratio	$\omega_1=$	1.0000e0	$\omega_2=$	1.0000e0
Total Porosity	$\Phi_{t1}=$	18.00 %	$\Phi_{t2}=$	18.00 %
Total Compressibility	$c_{t1}=$	7.062e-4 psi^{-1}	$c_{t2}=$	7.062e-4 psi^{-1}
Region Radius	$r_1=$	55.000 ft	$r_2=$	1000.000 ft

Skin (s)	-4.640
Turbulence Factor (D)	0.00 $(MMCF/D)^{-1}$
Apparent Wellbore Storage Dim. (C_{aD})	0.00
Wellbore Storage Constant Dim. (C_D)	500.00
Storage Pressure Param. Dim. (C_{pD})	0.000

Production and Pressure

Final Gas Rate	0.200 MMCF/D
Final Measured Pressure	psi
Initial Pressure (p_i)	1265.00 psi

Formation Parameters

Gas Saturation (S_g)	80.00 %
Water Saturation (S_w)	20.00 %
Oil Saturation (S_o)	0.00 %
Wellbore Radius (r_w)	0.33 ft
Formation Temperature (T)	115.0 °F

Synthesis Results

Average Error	0.92 %
Synthetic Initial Pressure (p_i)	1265.58 psi
Extrapolated Pressure at Specified Time	1262.07 psi
Pressure Drop Due To Skin (Δp_s)	psi
Flow Efficiency (FE)	5.714
Damage Ratio (DR)	0.175

Fluid Properties

Gas Gravity (G)	0.779
N_2	23.02 %
H_2S	0.00 %
CO_2	0.45 %
Critical Pressure (P_c)	629.87 psi
Critical Temperature (T_c)	356.86 R
PVT Reference Pressure (p_{PVT})	1265.00 psi
Gas Compressibility (c_g)	8.77219e-4 psi^{-1}
Gas Compressibility Factor (z)	0.865
Gas Viscosity (μ_g)	0.0154 cp
Gas Formation Volume Factor (B_g)	0.001974 bbl/scf

Forecasts

Specified Flowing Pressure (p_{wfs})	735.54 psi
3 - Month Constant Rate	0.233 MMCF/D
6 - Month Constant Rate	0.199 MMCF/D
Specified Forecast Time	12.00 month
Forecast Constant Rate @ Current Skin	0.154 MMCF/D
Forecast Constant Rate @ Skin=0	0.035 MMCF/D
Forecast Constant Rate @ Skin=-4	MMCF/D

Fast

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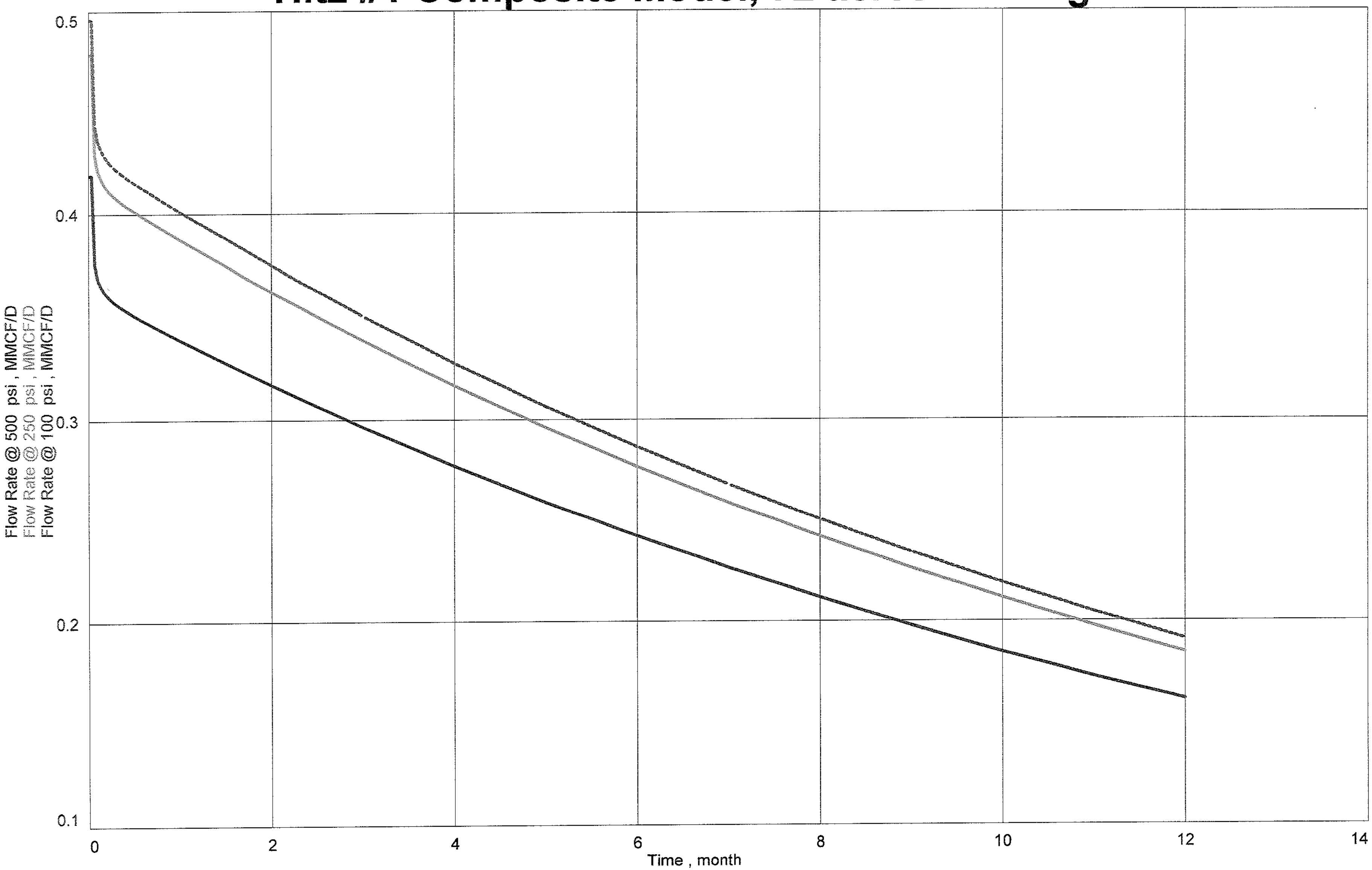
Lansing 3543'-3548'

Hitz #1 Composite Model, 72 acres Drainage



Transient Gas Forecast

Composite Model #1

Parrish Corp.
Stafford Co. Ks. Sec 5-23S-12W

Hitz #1
Lansing 3543'-3548'

Forecast @ 500 psi			Forecast @ 250 psi			Forecast @ 100 psi		
Time	Rate	Cum. Prod.	Time	Rate	Cum. Prod.	Time	Rate	Cum. Prod.
month	MMCF/D	MMCF	month	MMCF/D	MMCF	month	MMCF/D	MMCF
0.0000	0.419	0.0	0.0000	0.479	0.0	0.0000	0.496	0.0
0.0328	0.419	0.4	0.0328	0.479	0.5	0.0328	0.496	0.5
0.0656	0.376	0.8	0.0656	0.429	0.9	0.0656	0.444	0.9
0.0984	0.369	1.2	0.0984	0.422	1.3	0.0984	0.436	1.4
0.1311	0.366	1.5	0.1311	0.418	1.7	0.1311	0.432	1.8
0.1639	0.363	1.9	0.1639	0.415	2.2	0.1639	0.429	2.2
0.1967	0.361	2.3	0.1967	0.413	2.6	0.1967	0.427	2.7
0.2295	0.360	2.6	0.2295	0.411	3.0	0.2295	0.425	3.1
0.2623	0.358	3.0	0.2623	0.409	3.4	0.2623	0.424	3.5
0.2951	0.357	3.3	0.2951	0.408	3.8	0.2951	0.422	3.9
0.3279	0.356	3.7	0.3279	0.407	4.2	0.3279	0.421	4.4
0.3607	0.355	4.0	0.3607	0.406	4.6	0.3607	0.420	4.8
0.3934	0.354	4.4	0.3934	0.405	5.0	0.3934	0.419	5.2
0.4262	0.353	4.7	0.4262	0.404	5.4	0.4262	0.418	5.6
0.4590	0.352	5.1	0.4590	0.403	5.8	0.4590	0.417	6.0
0.4918	0.351	5.5	0.4918	0.402	6.2	0.4918	0.416	6.4
0.5246	0.351	5.8	0.5246	0.401	6.6	0.5246	0.415	6.9
0.5574	0.350	6.2	0.5574	0.400	7.0	0.5574	0.414	7.3
0.5902	0.349	6.5	0.5902	0.399	7.4	0.5902	0.413	7.7
0.6230	0.348	6.8	0.6230	0.398	7.8	0.6230	0.412	8.1
0.6557	0.347	7.2	0.6557	0.397	8.2	0.6557	0.411	8.5
0.6885	0.347	7.5	0.6885	0.396	8.6	0.6885	0.410	8.9
0.7213	0.346	7.9	0.7213	0.395	9.0	0.7213	0.409	9.3
0.7541	0.345	8.2	0.7541	0.394	9.4	0.7541	0.408	9.7
0.7869	0.344	8.6	0.7869	0.393	9.8	0.7869	0.407	10.1
0.8197	0.343	8.9	0.8197	0.392	10.2	0.8197	0.406	10.6
0.8525	0.343	9.3	0.8525	0.392	10.6	0.8525	0.405	11.0
0.8852	0.342	9.6	0.8852	0.391	11.0	0.8852	0.404	11.4
0.9180	0.341	9.9	0.9180	0.390	11.4	0.9180	0.403	11.8
0.9508	0.340	10.3	0.9508	0.389	11.8	0.9508	0.402	12.2
0.9836	0.340	10.6	0.9836	0.388	12.1	0.9836	0.402	12.6
1.0000	0.339	10.8	1.0000	0.387	12.3	1.0000	0.401	12.8
2.0000	0.317	20.5	2.0000	0.363	23.4	2.0000	0.375	24.2
3.0000	0.297	29.5	3.0000	0.339	33.7	3.0000	0.351	34.9
4.0000	0.277	38.0	4.0000	0.317	43.4	4.0000	0.328	44.9
5.0000	0.259	45.9	5.0000	0.296	52.4	5.0000	0.307	54.3
6.0000	0.242	53.3	6.0000	0.277	60.9	6.0000	0.287	63.0
7.0000	0.226	60.2	7.0000	0.259	68.8	7.0000	0.268	71.2
8.0000	0.212	66.6	8.0000	0.242	76.1	8.0000	0.250	78.8
9.0000	0.198	72.7	9.0000	0.226	83.0	9.0000	0.234	85.9
10.0000	0.185	78.3	10.0000	0.211	89.5	10.0000	0.219	92.6
11.0000	0.173	83.6	11.0000	0.198	95.5	11.0000	0.205	98.9
12.0000	0.162	88.5	12.0000	0.185	101.1	12.0000	0.191	104.7