Samples of Pressure Transient Analysis of Permian Basin Pumping Wells

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ABSTRACT

This paper provides five examples of pumping well buildups and the pressure transient analysis of the buildup data. The bottonhole pressure data is also included for each test. All of the buildup data was collected through the use of automatic acoustical fluid level machines. When the examples were picked an attempt was made to show typical buildup responses from Permian basin wells. Some of the buildups selected are from wells that are tight and have three phase flow. The tight wells have been stimulated, and do not fit the standard reservoir response models. The samples consist of a classic homogeneous buildup response, a well that has suffered a local reduction in permeability over time, a new drill from the same field, a well that sees interference from offset production during the buildup, and a well that has a changing storage; due to the fill up of a hydraulic fracture.

INTRODUCTION

The need for a method to obtain bottomhole pressures in pumping wells without pulling the rods and tubing, has long been recognized. This need for acoustical instruments for measuring bottomhole pressures in pumping oil wells has been great enough that several of the research departments of the major oil companies have pursued developing their own equipment. Most, if not all of the private programs to develop acoustic instruments ended with the recent public availability of equipment.

Modern Acoustical instruments provide an indirect method for the measurement of bottomhole pressures in shut-in pumping wells. The instruments collect the surface pressure and the location of the fluid level in the well. Using the fluid level, the surface pressure, and the production information, the bottomhole pressure can be calculated. The calculation is performed through the summation of the components of the surface pressure, the gas column pressure, and the hydrostatic pressure of the fluid level. The hydrostatic of the fluid column must be corrected for the aeration of the liquid by the gas influx during the after flow. Automatic acoustic equipment currently available to the industry includes the software to calculate the bottomhole pressures from the collected fluid levels and surface pressures. The ability of the automatic instruments to consistently locate the fluid level in the acoustic sound response has made the accurate calculation of bottomhole pressure with these instruments possible.

With the advent of automatic acoustic instruments to efficiently perform pumping well buildups, the continuing question has been what are the general limitations of the equipment, and on what type of pumping wells will this type of equipment provide accurate, buildup data.

To answer this question of what type of wells should acoustical data be collected on and used for the calculation of bottonhole pressures, one must look at the important basic assumptions used in the calculation of bottomhole pressures from acoustical data.

The two important assumptions used in the calculation of bottomhole pressures from acoustical data are:

1) Prior the start of the buildup test, all fluid above the pump is oil.

2) The water-oil ratio of the buildup afterflow remains the same as the producing water-oil ratio.

Of these two assumptions, a violation of the assumption of a constant water-oil ratio will give the larger error in the calculation of bottomhole pressures. With this in mind, wells with large producing intervals that are under or have been water flooded and that have significant cross flow between watered out stringers and lower permeability sections are not good candidates for acoustical buildups. The cross flow will tend to displace or swap out either the water or in some instances the oil in the fluid column. The crossflow can sometimes be detected by a change in the fluid level plot. The problem of fluid redistribution in the annulus of a pumping well during a buildup is probably only a problem for gross intervals of several hundred feet and has only been observed with gauge comparisons in one field with over 1000 feet of perforations, under water flood with an interval that was very heterogeneous.

Another question encountered with pumping well buildup data collection is how to treat foamy or highly aerated fluid columns. This problem can be addressed in two ways. The first and most practical methode is to shut-in the casing valve and depress the gas influx on the annulus. This technique works quite well but may change the fluid influx rate and the production of the well just prior the shut-in. The second technique is to take advantage of the characteristics of well bore storage and to simply plot back to the time of shut to get Pwf. This technique works well because very rarely will foam problems exceed several hours and conversely rarely will the wellbore storage be under 3-5 hours in a pumping well.

The technique of obtaining bottom hole pressures by utilizing acoustical equipment is not limited to beam pumping wells. This technique can be applied to a variety of wells utilizing several different types of artificial lift. A short list of the type of lift systems this technique applies is Electronic submersible pump, Gas lift, plunger lift and swabbing. To test the gas lift or swabbed wells the well sounder is connected to the tubing and the data collection is initiated immediately after the lifting operations cease.

WELL TEST EXAMPLES

The application of Acoustical instruments can provide accurate data that can be used in the calculation of reservoir properties. The following examples are from fields in the Permian Basin.

Classic Homogenous Response

This buildup was performed an a well completed in the San Andres formation. The field is relatively new, and this data was collected to set a baseline prior to the implementation of a water flood. One interesting aspect of the test results that are not show in this paper is that the buildup tests performed prior to this test all showed that the permeability to oil was decreasing with time and pressure. This test was also completed when the reservoir pressure was about to fall below the bubble point. Figure (1) shows the Cartesian plot of the buildup data. From the Cartesian plot the well bore storage (C) can be calculated. Figure (2) shows the derivative plot of the buildup data. From this plot it can be seen that the buildup pressure response is Radial Homogeneous with Storage and Skin. Figure (3) shows the superposition plot and the radial flow buildup results form the straight line. Figure (4) shows the linear regression match of the buildup data. Table (1) details the input parameters used in the analysis and the corresponding analysis results from the buildup. Table (2) shows the pressure time data calculated from the acoustical data collected during this buildup.

Reduced Permeability Well

This buildup was performed an a well completed in the Queen formation. The field was mature, and had just recently been acquired by a small independent that planned to improve the economics by infield drilling and by the implementation of a water flood. This data was collected to evaluate the reason for the poor water flood performance prior to the operator taking over the field. The results of the test showed why the water flood had been suspended. The effective permeability to oil from this test and a test on a near by well was very low. However, the operator performed a buildup test on a newly drilled well that showed a much lower pressure and an order of magnitude high permeability. From this and some other buildup tests, the operator concluded that the original producing wells had sustained a reduction of permeability that extended over 90 feet from the well. Figure (5) shows the Cartesian plot of the buildup data. Figure (6) shows the derivative plot of the data and as can be seen from the plot, the pressure response is Homogeneous Radial Flow with a negative Skin. Figure (7) shows the superposition plot and the radial flow buildup results from the straight line. Table (3) details the input parameters used in the analysis and the corresponding analysis results from the buildup. Table (4) shows the pressure time data calculated from the acoustical data collected during this buildup.

New Drill In Reduced Permeability Field

This buildup was performed an a well completed in the same Queen formation as the previous example. However, this well was a new drill that replaced a plugged producer. The results of the test showed that the portions of the field between the old producers had a much higher permeability. The effective permeability to oil from this test was an order of magnitude higher than on the older producers. From this and some other buildup tests, the operator concluded that the original producing wells had sustained a reduction of permeability that extended over 90 feet from the well. Figure (8) shows the Cartesian plot of the buildup data. Figure (9) shows the superposition plot and the radial flow buildup results from the straight line. Figure (10) shows the a Square Root of time plot of the data and as can be seen from the plot, the pressure response was linear and there was a small fracture induced during the acidizing of the well. Table (5) details the input parameters used in the analysis and the corresponding analysis results from the buildup. Table (6) shows the pressure time data calculated from the acoustical data collected during this buildup.

Well Showing Interference from offset

This buildup was performed on a well completed in the gas cap of a thick reservoir. The field was mature and the operator was doing a study on blowing down the gas cap. The results of the test provided the permeability and pressure information that the engineer had set for his test objectives. The interesting result from the test was that interference from offset production is clearly visible in data. Figure (11) shows the Cartesian plot of the buildup data. Figure (12) shows the derivative plot of the data and as can be seen from the plot, the pressure response is Homogeneous Radial Flow with a negative Skin. Figure (7) shows the superposition plot and the radial flow buildup results from the straight line. Both the derivative and the superposition plots show the affects of interference form offset production. Table (7) details the input parameters used in the analysis and the corresponding analysis results from the buildup. Table (8) shows the pressure time data calculated from the acoustical data collected during this buildup.

Buildup With Fracture Fillup That Affects Storage

This buildup was performed on a well completed in Grayburg formation. The engineer was seeking reservoir information in order to perform the economics of re-fracturing this well. The interesting aspect of this test was the well bore storage portion of the buildup. This well had been hydraulically fractured and was being considered for a re-fracture job. The pump in the well was set below the perforations. After the was shut-in the fluid level rose very slowly until it reached the top of the perforations. This slow rise was due to the fluid actually filling the hydraulic fracture. Once the fluid reached the top of the fracture, it started rise at a faster rate as can be seen in Figure (15). The fracture fillup was complete after twenty four hours. When the buildup was analyzed, the pressures collected during the fillup were discarded because the after flow during that time was the same as the well production. Figure (14) shows the Cartesian plot of the complete bottom hole pressure data. Figure (15) shows the a plot of fluid levels, surface pressures and calculated bottomhole pressures collected during the buildup. Figure (16) shows the superposition plot and the radial flow buildup results from the straight line. Figure (17) shows the results of a linear regression of the pressure data. Table (9) details the input parameters used in the analysis and the corresponding analysis results from the buildup. Table (10) shows the pressure time data calculated from the acoustical data collected during this buildup.

Conclusions

The buildup examples shown in this paper demonstrate that buildup data collected with acoustic well sounders can be analyzed and that even relatively tight wells can be tested and produce analyzable data. The data collected by acoustical sounders provides the same accuracy as mechanical gauges. The basic reason for this paper was to show what typical buildup data from pumping wells looks like. Utilizing Acoustic Well Sounders to collect the data during pumping well buildups can provide a large cost savings over pulling the well to run conventional pressure gauges. Besides the cost savings, utilizing automatic well sounders requires far less intrusion into the field operations and does not tie-up field personnel to supervise the workover operations at the well to be tested.

References

McCoy, J.N. et al.: "Acoustic Determination of Producing Bottomhole Pressure," paper SPE 14254 presented at the 1985 SPE Annual Technical Conference and Exhibition, Las Vegas, September 22-25.

Table 1

Input Parameters					Results	
Qo(bbl/day)	128	Bo	1.12		ko(eff)	13.123
Qw(bbl/day)	25	Bw	1.01		kw(eff)	0.201
Qg(mcf/day)	34.5	Bg(bbl/mcf)	2.29		kg(eff)	0
qtBt	168.61	h(ft)	79		S	-0.444
Th(hrs.)	1.26E+04	Por (%)	16.5		P*	1268
Ct	2.54 e-4	Tf (F)	101		Pave	1249.52
Vo	8.436	Sw	0.12		Pwf	97.68
Vw	0.7345	Gas Gravity	1.08			
Vg	0.0143	Oil Gravity	25.3			

Table 2

084

Datum Depth: 4566

Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)
0	97.68	13.1352	625.16	78.9073	849.79
0.0167	99.19	13.9913	638.55	81.0019	851.78
0.0333	100.77	14.8749	651.4	83.1241	853.71
0.05	102.36	15.7861	663.07	85.2737	855.59
0.0667	103.95	16.7247	673.11	87.4509	857.41
0.0833	105.54	17.6909	682.77	89.6556	859.21
0.1	107.13	18.6846	692.19	91.8879	861.09
0.1167	108.72	19.7059	701.72	94.1476	862.99
0.1333	110.43	20.7546	711.02	96.4349	864.91
0.15	112.75	21.8309	720.03	98.7497	866.86
0.1667	115.03	22.9347	728.69		
0.1833	117.19	24.0661	736.54		
0.2	119.27	25.2249	743.72		
0.2167	121.29	26.4113	750.25		
0.2333	123.27	27.6252	755.88		
0.25	125.21	28.8666	760.73		
0.2804	128.56	30.1356	765.62		
0.3384	134.79	31.432	770.18		
0.4239	143.88	32.756	774.45		
0.5368	155.7	34.1075	778.5		
0.6774	170.33	35.4866	782.38		
0.8454	187.68	36.8931	786.2		
1.041	206.36	38.3272	789.95		
1.2641	223.58	39.7888	793.62		
1.5147	240.79	41.2779	797.21		
1.7928	259.07	42.7946	800.75		
2.0985	278.18	44.3388	803.77		
2.4316	297.55	45.9105	806.35		
2.7923	317.12	47.5097	808.86		
3.1805	336.97	49.1364	811.36		
3.5963	357.32	50.7907	813.86		
4.0396	377.6	52.4725	816.35		
4.5103	398.01	54.1818	818.83		
5.0087	418.22	55.9186	821.37		
5.5345	438.35	57.6829	823.95		
6.0879	457.16	59.4748	826.51		
6.6687	474.53	61.2942	829.07		
7.2771	491.82	63.1411	831.61		
7.9131	509.05	65.0156	834.15		
8.5765	526.26	66.9175	836.69		
9.2675	543.49	68.847	839.11		
9.986	560.92	70.804	841.36		
10.732	578.32	72.7886	843.54		
11.5055	595.4	74.8006	845.67		
12.3066	611.13	76.8402	847.75		

034

Table 3

Input Parameters						Results	
Qo(bbl/day)	2		Bo	1.22		ko(eff)	0.03
Qw(bbl/day)	28		Bw	1		kw(eff)	0.135
Qg(mcf/day)	1.5		Bg(bbl/mcf)	0.88		kg(eff)	1.20E-04
qtBt	31.302					S	-2.54
Th(hrs.)	1.52E+04		Por (%)	14		P*	4160.77
Ct	2.80E-05		Tf (F)	90		Pave	4118.25
Vo	2.13		Sw	0.35		Pwf	38.57
Vw	0.8269						
Vg	0.0174						

Table 4

034

Datum Depth : 4808

Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)
0	38.57	22.3944	1001.6	136.7774	2267.85
0.0167	39.23	23.8781	1051.57	140.4255	2279.34
0.0333	39.9	25.4098	1099.79	144.1217	2290.22
0.05	40.6	26.9897	1145.8	147.866	2300.38
0.0667	41.36	28.6177	1189.84	151.6584	2309.89
0.0833	42.05	30.2937	1232.81	155.4989	2319.16
0.1	42.73	32.0179	1275.21	159.3875	2328.08
0.1167	43.4	33.7902	1317.06	163.3242	2336.4
0.1333	44.08	35.6105	1358.16	167.3091	2343.97
0.15	44.76	37.479	1398.36	171.3419	2351.61
0.1667	45.44	39.3956	1437.53		
0.1833	46.11	41.3602	1475.7		
0.2	46.79	43.373	1512.77		
0.2167	47.47	45.4338	1548.59		
0.2333	48.14	47.5428	1582.77		
0.25	48.82	49.6999	1615.68		
0.2907	50.48	51.905	1647.91		
0.3795	54.09	54.1583	1679.79		
0.5164	59.69	56.4596	1711.49		
0.7015	67.53	58.8091	1742.88		
0.9346	77.77	61.2066	1773.8		
1.2158	90.48	63.6523	1804.05		
1.5451	105.71	66.146	1833.37		
1.9225	123.52	68.6879	1861.24		
2.348	143.87	71.2778	1887.87		
2.8216	166.82	73.9158	1913.62		
3.3433	192.47	76.602	1938.7		
3.9131	220.74	79.3362	1963.29		
4.531	251.04	82.1186	1987.18		
5.197	283.54	84.949	2010.12		
5.9111	318.41	87.8275	2031.89		
6.6733	355.62	90.7542	2052.18		
7.4836	394.71	93.7289	2070.66		
8.342	434.93	96.7517	2087.89		
9.2485	476.5	99.8226	2104.66		
10.2031	519.43	102.9417	2121.13		
11.2057	563.76	106.1088	2137.33		
12.2565	609.47	109.324	2153.37		
13.3554	656.73	112.5874	2169.27		
14.5024	704.98	115.8988	2184.87		
15.6975	753.43	119.2583	2200.09		
16.9407	800.81	122.6659	2214.86		
18.2319	848.74	126.1216	2229.2		
19.5713	899.76	129.6254	2242.87		
20.9588	950.26	133.1774	2255.74		

Table 5

Input Parameters					Results	
Qo(bbl/day)	24		Bo	1.05		ko(eff)	1.217
Qw(bbl/day)	5.7		Bw	1.01		kw(eff)	0.042
Qg(mcf/day)	3.5		Bg(bbl/mcf)	4.88		kg(eff)	0.008
qtBt	30.923		h(ft)	25		S	-3.6
Th(hrs.)	8.40E+03		Por (%)	25		P*	847.87
Ct	2.99E-04		Tf (F)	100		Pave	847.18
Vo	4.508		Sw	0.35		Pwf	55.19
Vw	0.7425		Gas Gravity	0.65			
Vg	0.0109		Oil Gravity	30			

Table 6

041

Datum Depth : 4893

Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)
0	55.19	9.9969	160.92	70.4299	392.2
0.0167	55.39	10.9298	167.82	72.897	397.95
0.0333	55.59	11.9053	174.66	75.4067	403.71
0.05	55.79	12.9234	181.53	77.959	409.5
0.0667	55.99	13.9842	188.45	80.554	415.3
0.0833	56.18	15.0876	195.36	83.1915	421.07
0.1	56.44	16.2336	202.19	85.8717	426.82
0.1167	56.69	17.4222	208.92	88.5945	432.51
0.1333	56.95	18.6534	215.53	91.3599	438.14
0.15	57.2	19.9273	222.04	94.1679	443.69
0.1667	57.45	21.2437	228.54	97.0186	449.11
0.1833	57.71	22.6028	235.07	99.9118	454.4
0.2	57.96	24.0045	241.65	102.8477	459.56
0.2167	58.22	25.4488	248.32	105.8262	464.57
0.2333	58.47	26.9357	255.12	108.8473	469.49
0.25	58.73	28.4653	261.75	111.911	474.32
0.288	59.3	30.0374	268.22	115.0174	479.15
0.3686	60.54	31.6522	274.58	118.1663	484.07
0.4918	62.42	33.3096	280.87	121.3579	489.05
0.6576	64.95	35.0096	287.11	124.5921	494.09
0.866	68.12	36.7522	293.31	127.8689	499.17
1.1171	71.91	38.5374	299.51	131.1883	504.26
1.4108	76.29	40.3653	305.74	134.5503	509.29
1.747	81.15	42.2358	312.01	137.955	514.25
2.126	86.36	44.1488	318.32	141.4022	519.12
2.5475	91.71	46.1045	324.66	144.8921	523.88
3.0116	97.1	48.1029	331.08	148.4246	528.66
3.5184	102.57	50.1438	337.6	151.9997	533.5
4.0677	108.24	52.2273	344.16		
4.6597	114.21	54.3535	350.75		
5.2943	120.47	56.5223	357.47		
5.9715	126.96	58.7337	363.65		
6.6914	133.62	60.9877	369.47		
7.4538	140.36	63.2843	375.13		
8.2589	147.14	65.6236	380.79		
9.1066	153.99	68.0054	386.48		

Table 7

Input Parameters						Results	
Qo(bbl/day)	30		Bo	1.2		ko(eff)	1.781
Qw(bbl/day)	300		Bw	1.01		kw(eff)	5.648
Qg(mcf/day)	200		Bg(bbl/mcf)	1.35		kg(eff)	0.849
qtBt	552.716		h(ft)	60		S	-1.33
Th(hrs.)	1.82E+02		Por (%)	4		P*	1543.43
Ct	1.32E-04		Tf (F)	105		Pave	1540.66
Vo	1.8689		Sw	0.5		Pwf	994.48
Vw	0.7036		Gas Gravity	0.88			
Vg	0.0152		Oil Gravity	34			

Table 8

012

Datum Depth : 4676

Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)
0	994.48	15.5886	1427.04	98.6356	1480.34
0.0167	994.38	16.7286	1431.3	101.4911	1479.74
0.0333	997.05	17.9094	1433.06	104.3875	1479.03
0.05	999.82	19.131	1435.19	107.3247	1478.22
0.0667	1002.58	20.3935	1437.8	110.3028	1477.36
0.0833	1005.32	21.6969	1440.85	113.3216	1476.54
0.1	1008.06	23.041	1444.42	116.3814	1475.74
0.1167	1010.78	24.4261	1448.78	119.482	1474.97
0.1333	1014.44	25.852	1452.68	122.6234	1474.27
0.15	1023.21	27.3187	1455.81	125.8057	1473.65
0.1667	1032.1	28.8262	1458.27	129.0288	1473.13
0.1833	1040.3	30.3747	1460.03	132.2928	1472.58
0.2	1047.9	31.9639	1460.49	135.5977	1471.97
0.2167	1055	33.594	1462.79	138.9434	1471.36
0.2333	1061.67	35.265	1463.81	142.3299	1470.79
0.25	1067.94	36.9768	1465.41	145.7572	1470.24
0.2871	1079.17	38.7295	1467.31		
0.365	1100.23	40.523	1469		
0.4838	1128.07	42.3573	1470.36		
0.6434	1155.44	44.2325	1471.4		
0.8439	1178.85	46.1485	1472.11		
1.0852	1201.42	48.1054	1472.5		
1.3674	1225.98	50.1032	1472.6		
1.6904	1257.24	52.1417	1472.77		
2.0543	1284.48	54.2212	1473.12		
2.459	1305.16	56.3414	1473.64		
2.9046	1327.9	58.5026	1474.34		
3.391	1347.96	60.7045	1475.2		
3.9182	1360.44	62.9473	1476.23		
4.4863	1371.52	65.231	1477.16		
5.0953	1382.21	67.5555	1477.94		
5.745	1392.31	69.9208	1478.62		
6.4357	1398.21	72.327	1479.23		
7.1672	1401.62	74.7741	1479.8		
7.9395	1406.24	77.262	1480.31		
8.7527	1404.36	79.7907	1480.77		
9.6067	1411.33	82.3603	1481.17		
10.5016	1414.15	84.9708	1481.42		
11.4373	1420.59	87.622	1481.49		
12.4139	1421.41	90.3142	1481.41		
13.4313	1419.23	93.0471	1481.19		
14.4895	1419.5	95.8209	1480.83		

Table 9

Input Parameters					Results	
Qo(bbl/day)	4	Bo	1.09		ko(eff)	0.028
Qw(bbl/day)	2	Bw	1.01		kw(eff)	0.004
Qg(mcf/day)	1.7	Bg(bbl/mcf)	3.71		kg(eff)	0
qtBt	6.38	h(ft)	88		S	-3.075
Th(hrs.)	4.35E+03	Por (%)	6		P*	1542.03
Ct	1.76E-04	Tf (F)	97		Pave	1541.35
Vo	2.424	Sw	30		Pwf	166.28
Vw	0.7669	Gas Gravity	0.956			
Vg	0.0125	Oil Gravity	36.5			

Table 10

056

Datum Depth : 4120

Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)	Elapsed Time HH.xxxx	BHP (psia)
0	49.37	36.2222	199.52	220.2805	591.77
0.0167	49.51	38.5632	209.73	226.0158	599.64
0.0333	49.65	40.9781	219.75	231.8249	607.53
0.05	49.8	43.4667	229.69	237.7078	615.46
0.0667	49.94	46.029	239.29	243.6645	623.42
0.0833	50.08	48.6652	248.72	249.6949	631.45
0.1	50.22	51.3752	257.97	255.7992	639.57
0.1167	50.36	54.1589	267.01	261.9772	647.78
0.1333	50.5	57.0165	275.88		
0.15	50.64	59.9478	284.67		
0.1667	50.78	62.9529	293.39		
0.1833	50.92	66.0318	302.03		
0.2	51.06	69.1845	310.67		
0.2167	51.2	72.411	319.43		
0.2333	51.34	75.7113	328.35		
0.25	51.48	79.0853	337.41		
0.3036	51.93	82.5332	346.58		
0.4309	52.88	86.0548	355.68		
0.6321	54.2	89.6502	364.71		
0.907	55.84	93.3195	373.7		
1.2557	57.78	97.0625	382.68		
1.6782	60.01	100.8793	391.65		
2.1745	62.53	104.7698	400.51		
2.7446	65.35	108.7342	409.24		
3.3885	68.46	112.7724	417.8		
4.1061	71.88	116.8843	426.14		
4.8976	75.56	121.0701	434.28		
5.7628	79.48	125.3296	442.28		
6.7018	83.6	129.6629	450.13		
7.7146	87.87	134.07	457.84		
8.8013	92.34	138.5509	465.47		
9.9616	97.05	143.1056	473.18		
11.1958	102.01	147.7341	481.01		
12.5038	107.16	152.4363	488.94		
13.8856	112.43	157.2124	496.98		
15.3411	117.66	162.0622	505.09		
16.8705	122.75	166.9858	513.17		
18.4736	127.82	171.9833	521.2		
20.1505	132.92	177.0545	529.18		
21.9012	137.88	182.1995	537.09		
23.7257	142.55	187.4182	544.92		
25.624	146.98	192.7108	552.71		
27.5961	154.86	198.0772	560.5		
29.6419	166.28	203.5173	568.3		
31.7616	177.75	209.0313	576.09		
33.955	188.86	214.619	583.92		

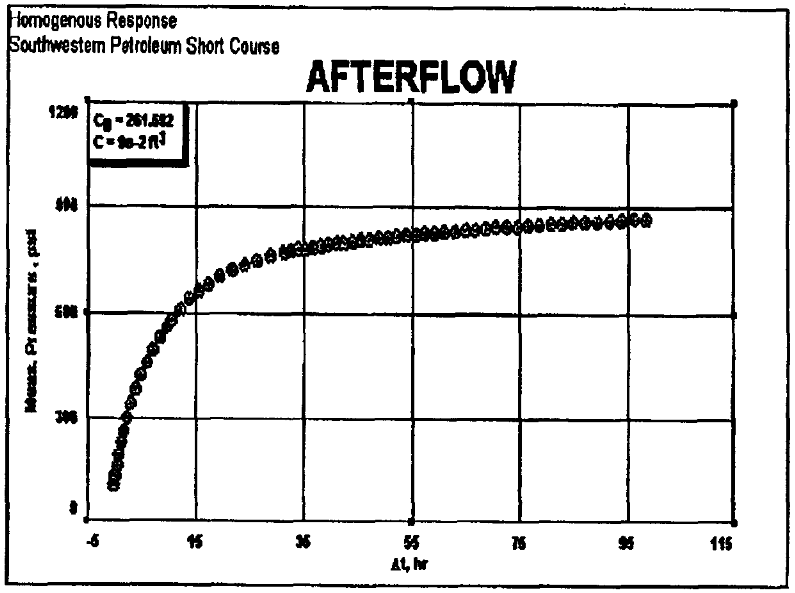


Figure 1

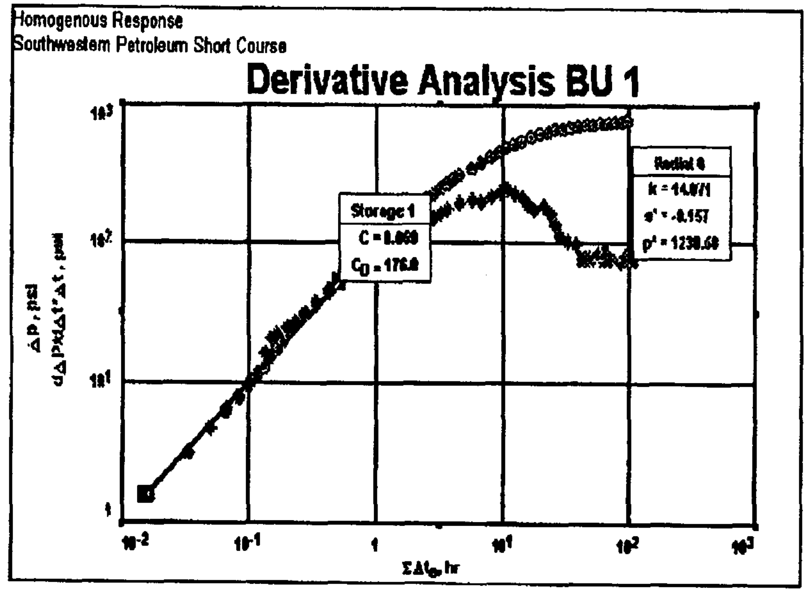


Figure 2

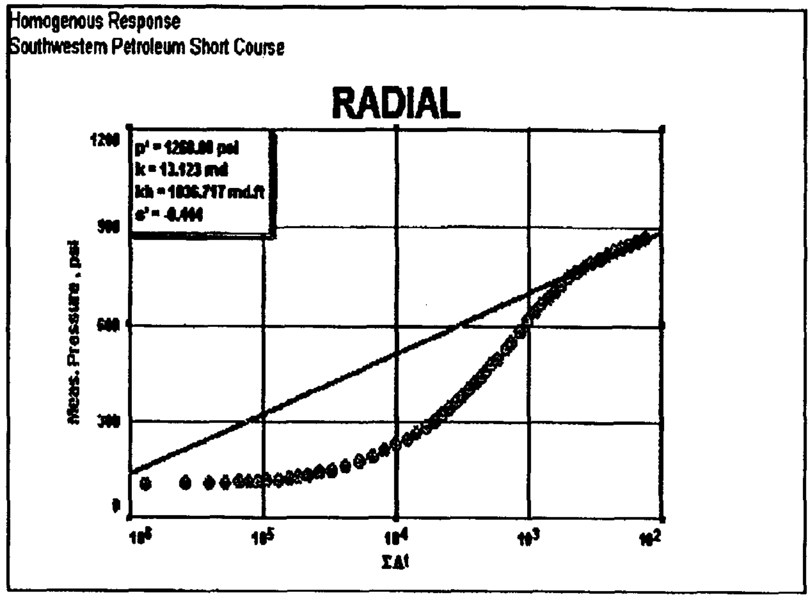


Figure 3

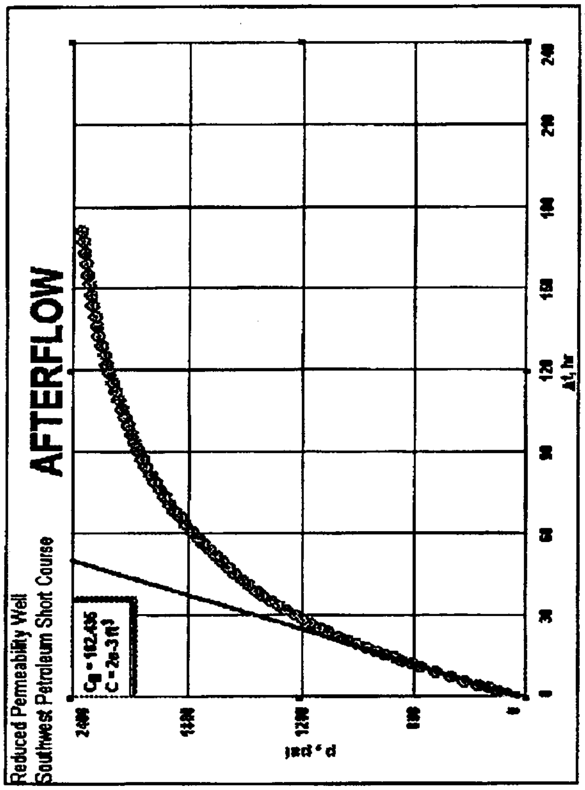
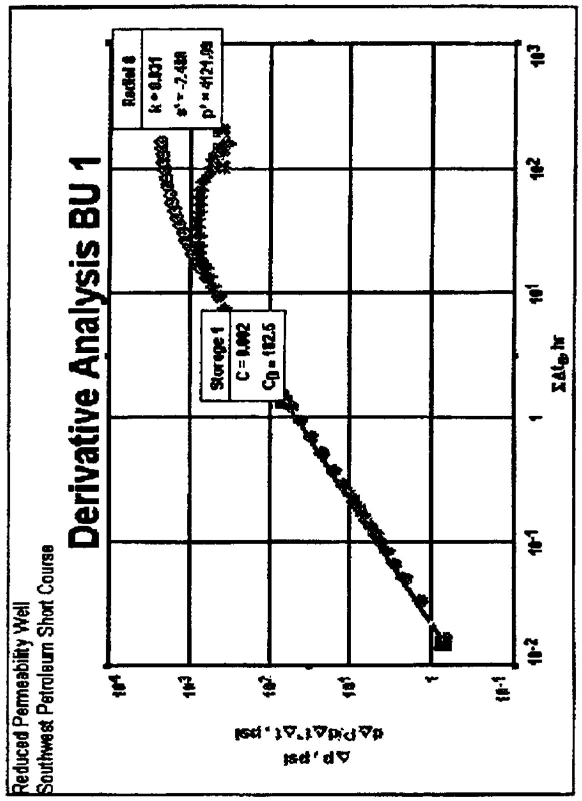


Figure 5



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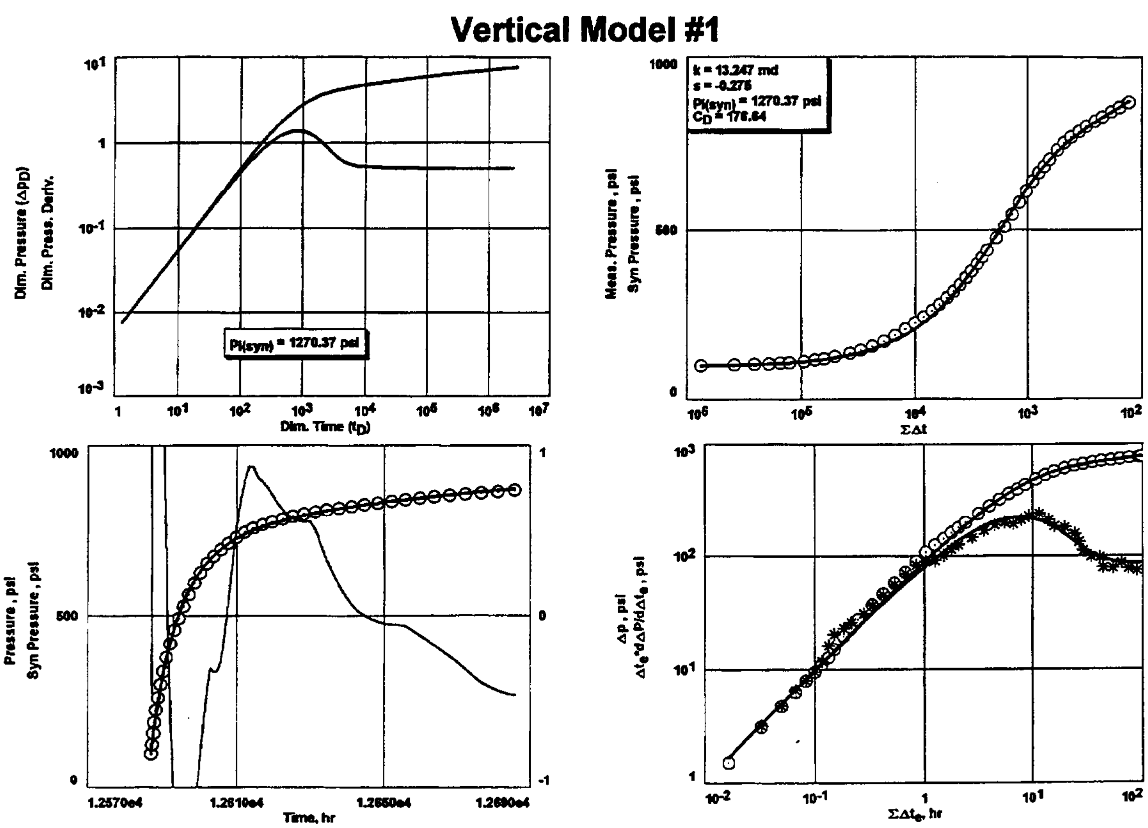
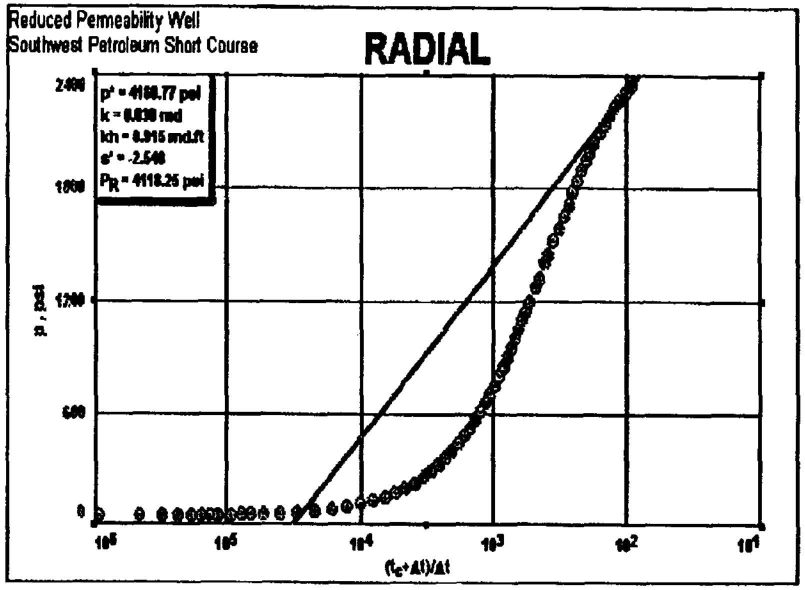


Figure 4



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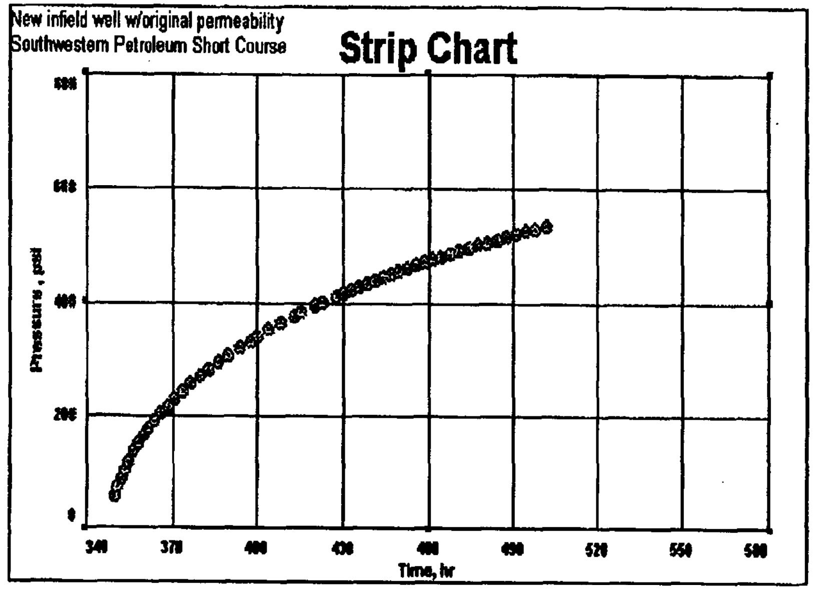

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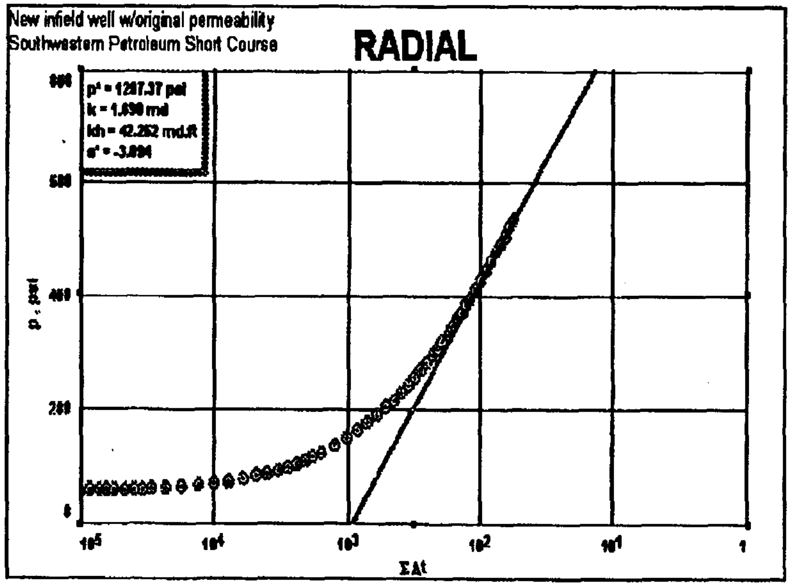
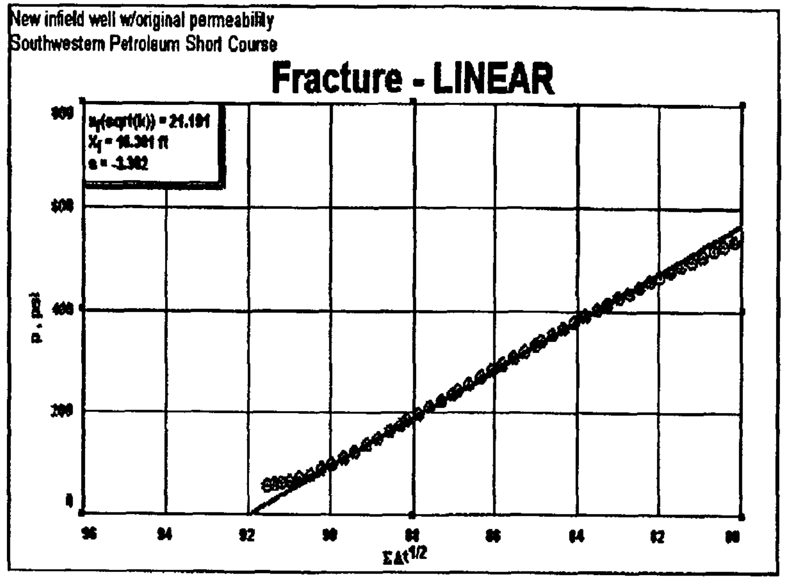


Figure 9



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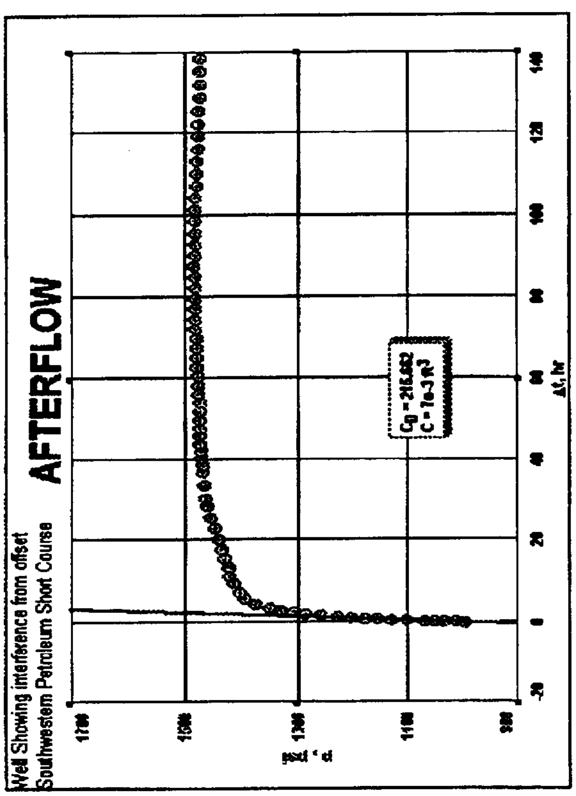

Figure 11

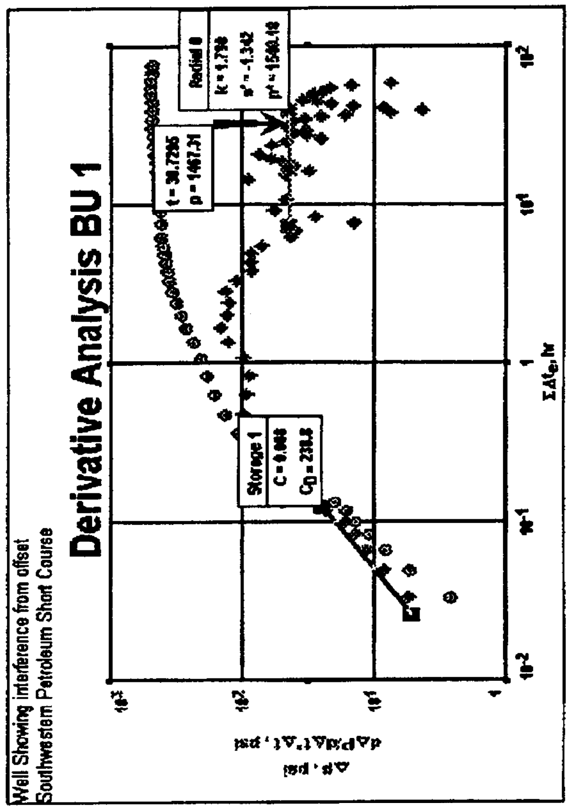

Figure 12

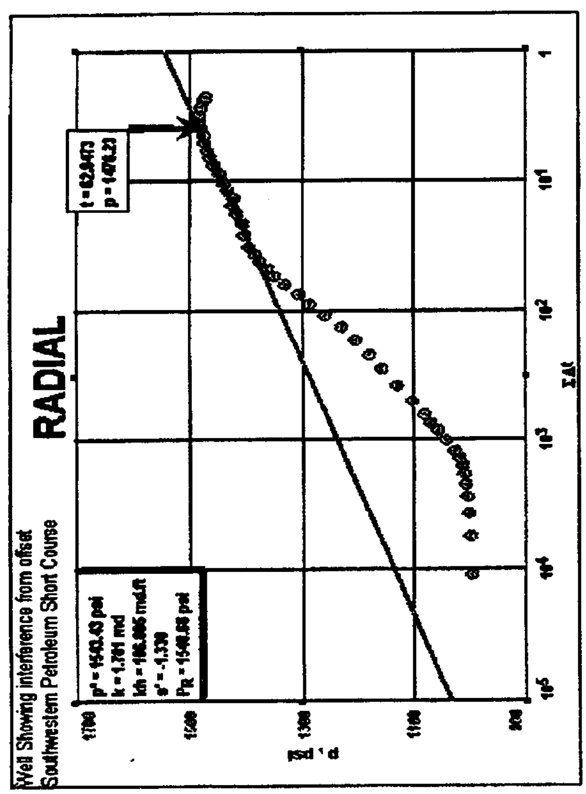

Figure 13

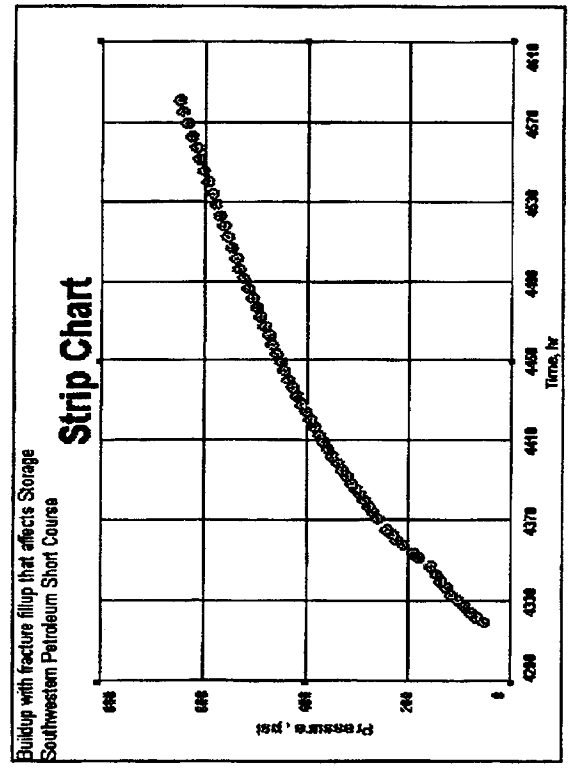

Figure 14

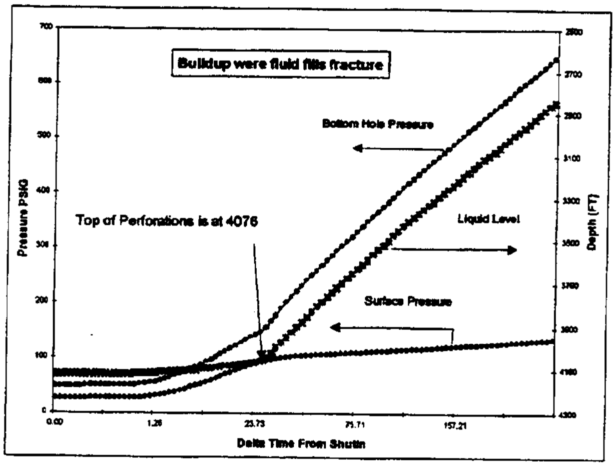

Figure 15

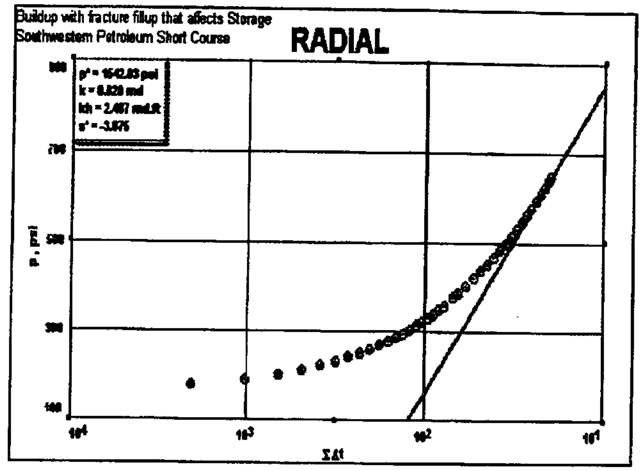

Figure 16

Vertical Model #2

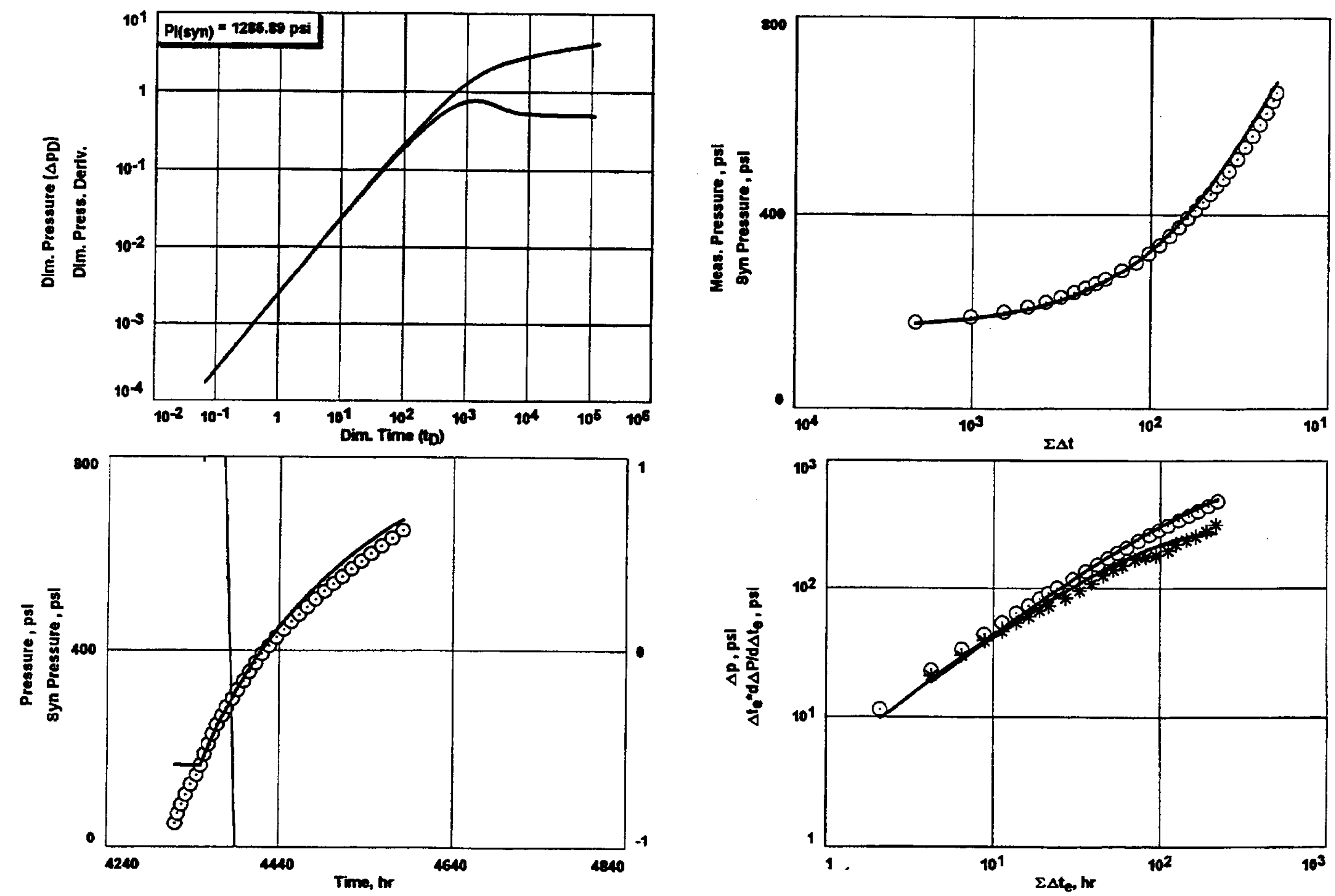

Figure 17