TABLE 1 — DIMENSIONLESS WELLBORE PRESSURE DROP FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE AT THE CENTER OF A CONSTANT-PRESSURE SQUARE

$t_{Dx_f} = 4(x_e/x_f)^2(t_{DA})$

Dimensionless Time, t_{DA} — Fracture Penetration Ratio, x_e/x_f	Dimensionless Wellbore Pressure Drop, p_{wD}*							
	1	1.5	2	3	5	7	10	15
0.00200	0.15784							
0.00300	0.19142							
0.00400	0.21820							
0.00500	0.24050							
0.00600	0.25962							
0.00700	0.27635	0.40797						
0.00800	0.29123	0.43153						
0.00900	0.30462	0.45325						
0.01000	0.31679	0.47346						
0.01500	0.36368	0.54979	0.69375	0.94886	1.31317	1.65473	1.99999	2.38611
0.02000	0.40058	0.62611	0.78873	1.07177	1.50330	1.81527	2.15836	2.55643
0.03000	0.45173	0.73127	0.92096	1.23463	1.68940	2.00912	2.35661	2.75712
0.04000	0.48851	0.81138	1.02216	1.35602	1.82405	2.14790	2.49769	2.89946
0.05000	0.51689	0.87491	1.10259	1.45129	1.92829	2.25483	2.60608	3.00864
0.06000	0.53954	0.92623	1.16763	1.52790	2.01157	2.34006	2.69237	3.09550
0.07000	0.55790	0.96805	1.22066	1.59019	2.07910	2.40909	2.76222	3.16579
0.08000	0.57287	1.00227	1.26405	1.64110	2.13421	2.46542	2.81919	3.22310
0.09000	0.58513	1.03031	1.29962	1.68281	2.17934	2.51152	2.86582	3.27002
0.10000	0.59518	1.05332	1.32880	1.71702	2.21634	2.54932	2.90405	3.30847
0.20000	0.63481	1.14405	1.44388	1.85192	2.36223	2.69834	3.05475	3.46008
0.30000	0.64031	1.15665	1.45987	1.87066	2.38249	2.71903	3.07568	3.48113
0.40000	0.64108	1.15840	1.46209	1.87326	2.38531	2.72191	3.07859	3.48406
0.50000	0.64118	1.15865	1.46240	1.87362	2.38570	2.72231	3.07899	3.48446
> 0.60000	0.64120	1.15868	1.46244	1.87368	2.38575	2.72236	3.07905	3.48452

*Values of p_{wD} for times smaller than that shown here are identical to the closed outer boundary case.

coordinates and is commonly referred to as the one-half slope line. After a transition period, a pseudo-radial flow period exists. Data in the pseudo-radial flow period have a characteristic slope of 1.151/log~ on semilog coordinates. This period, however, exists for only certain values of x_e/x_f. For the uniform-flux case, this period is absent for fracture penetration ratios less than 3 and for infinite-conductivity fractures for x_e/x_f less than 5. After a second transition period, steady-state flow occurs for all x_e/x_f similar to that of an unfractured well in a constant-pressure square. This period is analogous to pseudo-steady-state flow behavior for wells in closed systems. During steady state the pressure at each point in the system is time invariant. The system reaches steady state at a t_{DA} of about 0.4 for all x_e/x_f.

For practical purposes, Figs. 2 and 3 may be used for type-curve matching for the appropriate fracture type.[2] If a drainage limit became evident during the test, then data points would follow the appropriate x_e/x_f line. If the system under study is located in a constant-pressure square, then field data would fall below the $x_e/x_f = \infty$ curve and follow the appropriate x_e/x_f line. On the other hand, if the system boundaries are closed, then data would rise above the $x_e/x_f = \infty$ curve and follow the corresponding x_e/x_f line. Figs. 2 and 3 also may be used for analyzing falloff or buildup data.[1,2] This aspect of pressure analysis will be considered in the section on shut-in pressure behavior.

For unfractured wells, Hurst *et al.*[8] remarked that the time at which system boundaries (closed or constant-pressure) affect pressure behavior is the same; that is, curves influenced by outer boundary

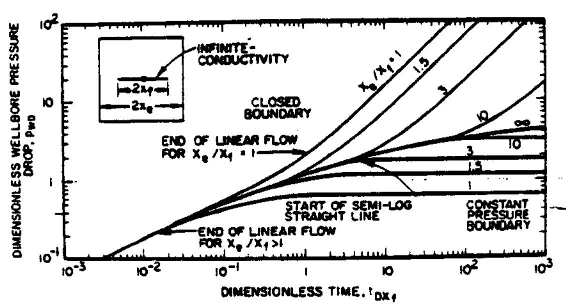

FIG. 2 — DIMENSIONLESS WELLBORE PRESSURE DROP VS DIMENSIONLESS TIME FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE.

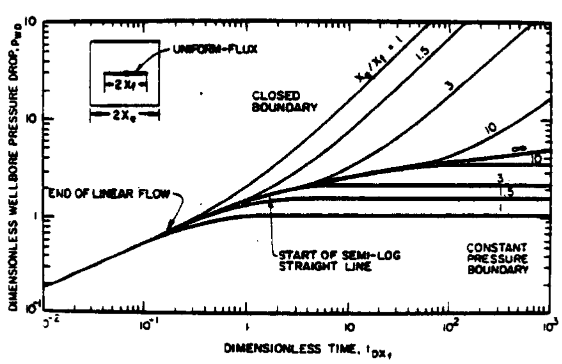

FIG. 3 — DIMENSIONLESS WELLBORE PRESSURE DROP VS DIMENSIONLESS TIME FOR A UNIFORM-FLUX VERTICAL FRACTURE.

DIMENSIONLESS WELLBORE PRESSURE DROP
FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE
AT THE CENTER OF A CONSTANT-PRESSURE SQUARE
(AFTER R. RAGHAVAN AND NICO HADINOTO)

TRANSACTION AIME 1978 VOLUME 265, PAGE 139

$TD(xf) = 4(xe/xf)^2 (tDA)$

Dimensionless Time, tDA -	Dimensionless Wellbore Pressure Drop, pwD	TD(xf) for Fracture Penetration Ratio of 1
0.00200	0.15784	0.00800
0.00300	0.19142	0.01200
0.00400	0.21820	0.01600
0.00500	0.24050	0.02000
0.00600	0.25962	0.02400
0.00700	0.27635	0.02800
0.00800	0.29123	0.03200
0.00900	0.30462	0.03600
0.01000	0.31679	0.04000
0.01500	0.36368	0.06000
0.02000	0.40058	0.08000
0.03000	0.45173	0.12000
0.04000	0.48851	0.16000
0.05000	0.51689	0.20000
0.06000	0.53954	0.24000
0.07000	0.55790	0.28000
0.08000	0.57287	0.32000
0.09000	0.58513	0.36000
0.10000	0.59518	0.40000
0.20000	0.63481	0.80000
0.30000	0.64031	1.20000
0.40000	0.64108	1.60000
0.50000	0.64118	2.00000
0.60000	0.64120	2.40000

DIMENSIONLESS WELLBORE PRESSURE DROP
FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE
AT THE CENTER OF A CONSTANT-PRESSURE SQUARE
(AFTER R. RAGHAVAN AND NICO HADINOTO)

TRANSACTION AIME 1978 VOLUME 265, PAGE 139

Dimensionless Time, tDA -	Dimensionless Wellbore Pressure Drop, pwD	$TD(xf) = 4(xe/xf)^2 (tDA)$ TD(xf) for Fracture Penetration Ratio of 1.5
0.00200		
0.00300		
0.00400		
0.00500		
0.00600		
0.00700	0.40797	0.06300
0.00800	0.43153	0.07200
0.00900	0.45325	0.08100
0.01000	0.47346	0.09000
0.01500	0.54979	0.13500
0.02000	0.62611	0.18000
0.03000	0.73127	0.27000
0.04000	0.81138	0.36000
0.05000	0.87491	0.45000
0.06000	0.92623	0.54000
0.07000	0.96805	0.63000
0.08000	1.00227	0.72000
0.09000	1.03031	0.81000
0.10000	1.05332	0.90000
0.20000	1.14405	1.80000
0.30000	1.15665	2.70000
0.40000	1.15840	3.60000
0.50000	1.15865	4.50000
0.60000	1.15868	5.40000

DIMENSIONLESS WELLBORE PRESSURE DROP
FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE
AT THE CENTER OF A CONSTANT-PRESSURE SQUARE
(AFTER R. RAGHAVAN AND NICO HADINOTO)

TRANSACTION AIME 1978 VOLUME 265, PAGE 139

$TD(xf) = 4(xe/xf)^2 (tDA)$

Dimensionless Time, tDA -	Dimensionless Wellbore Pressure Drop, pwD	TD(xf) for Fracture Penetration Ratio of 2
0.00200		
0.00300		
0.00400		
0.00500		
0.00600		
0.00700		
0.00800		
0.00900		
0.01000		
0.01500	0.69375	0.24000
0.02000	0.78873	0.32000
0.03000	0.92096	0.48000
0.04000	1.02216	0.64000
0.05000	1.10259	0.80000
0.06000	1.16763	0.96000
0.07000	1.22066	1.12000
0.08000	1.26405	1.28000
0.09000	1.29962	1.44000
0.10000	1.32880	1.60000
0.20000	1.44388	3.20000
0.30000	1.45987	4.80000
0.40000	1.46209	6.40000
0.50000	1.46240	8.00000
0.60000	1.46244	9.60000

DIMENSIONLESS WELLBORE PRESSURE DROP
FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE
AT THE CENTER OF A CONSTANT-PRESSURE SQUARE
(AFTER R. RAGHAVAN AND NICO HADINOTO)

TRANSACTION AIME 1978 VOLUME 265, PAGE 139

$TD(xf) = 4(xe/xf)^2 (tDA)$

Dimensionless Time, tDA -	Dimensionless Wellbore Pressure Drop, pwD	TD(xf) for Fracture Penetration Ratio of 3
0.00200		
0.00300		
0.00400		
0.00500		
0.00600		
0.00700		
0.00800		
0.00900		
0.01000		
0.01500	0.94886	0.54000
0.02000	1.07177	0.72000
0.03000	1.23463	1.08000
0.04000	1.35602	1.44000
0.05000	1.45129	1.80000
0.06000	1.52790	2.16000
0.07000	1.59019	2.52000
0.08000	1.64110	2.88000
0.09000	1.68281	3.24000
0.10000	1.71702	3.60000
0.20000	1.85192	7.20000
0.30000	1.87066	10.80000
0.40000	1.87326	14.40000
0.50000	1.87362	18.00000
0.60000	1.87368	21.60000

DIMENSIONLESS WELLBORE PRESSURE DROP
FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE
AT THE CENTER OF A CONSTANT-PRESSURE SQUARE
(AFTER R. RAGHAVAN AND NICO HADINOTO)

TRANSACTION AIME 1978 VOLUME 265, PAGE 139

$$TD(xf) = 4(xe/xf)^2 (tDA)$$

Dimensionless Time, tDA -	Dimensionless Wellbore Pressure Drop, pwD	TD(xf) for Fracture Penetration Ratio of 5
0.00200		
0.00300		
0.00400		
0.00500		
0.00600		
0.00700		
0.00800		
0.00900		
0.01000		
0.01500	1.31317	1.50000
0.02000	1.50330	2.00000
0.03000	1.68940	3.00000
0.04000	1.82405	4.00000
0.05000	1.92829	5.00000
0.06000	2.01157	6.00000
0.07000	2.07910	7.00000
0.08000	2.13421	8.00000
0.09000	2.17934	9.00000
0.10000	2.21634	10.00000
0.20000	2.36223	20.00000
0.30000	2.38249	30.00000
0.40000	2.38531	40.00000
0.50000	2.38570	50.00000
0.60000	2.38575	60.00000

DIMENSIONLESS WELLBORE PRESSURE DROP
FOR AN INFINITE-CONDUCTIVITY VERTICAL FRACTURE
AT THE CENTER OF A CONSTANT-PRESSURE SQUARE
(AFTER R. RAGHAVAN AND NICO HADINOTO)

TRANSACTION AIME 1978 VOLUME 265, PAGE 139

$TD(xf) = 4(xe/xf)^2 (tDA)$

Dimensionless Time, tDA -	Dimensionless Wellbore Pressure Drop, pwD	TD(xf) for Fracture Penetration Ratio of 10
0.00200		
0.00300		
0.00400		
0.00500		
0.00600		
0.00700		
0.00800		
0.00900		
0.01000		
0.01500	1.99999	6.00000
0.02000	2.15836	8.00000
0.03000	2.35661	12.00000
0.04000	2.49769	16.00000
0.05000	2.60608	20.00000
0.06000	2.69237	24.00000
0.07000	2.76222	28.00000
0.08000	2.81919	32.00000
0.09000	2.86582	36.00000
0.10000	2.90405	40.00000
0.20000	3.05475	80.00000
0.30000	3.07568	120.00000
0.40000	3.07859	160.00000
0.50000	3.07899	200.00000
0.60000	3.07905	240.00000