Methane Hydrates Code Comparison

Set-up for Problem 7 (Long-term simulations for Mt Elbert and PBU L-Pad “Like” Deposits)

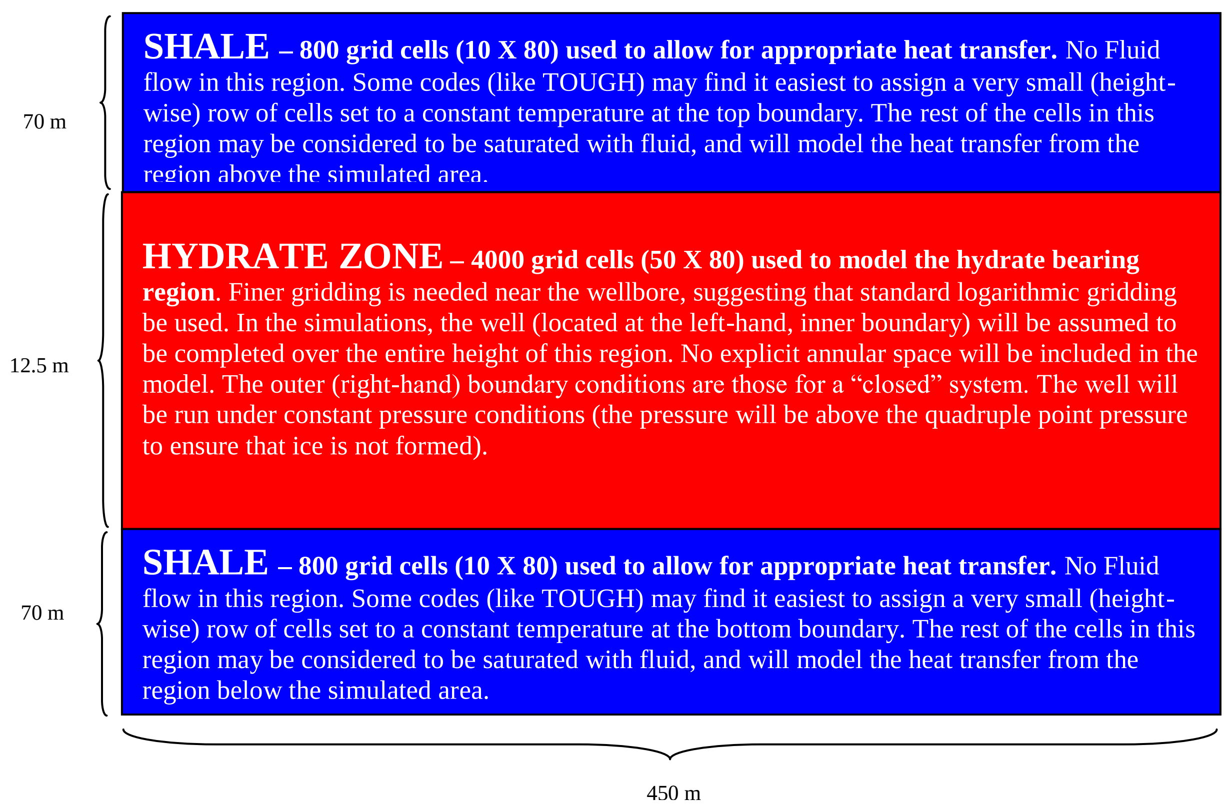
As discussed in the phone conference held on 11/9/2007, it is proposed that Problem 7 be made up of three separate cases: Problem 7a will look at a deposit similar to the Mt Elbert site. Problem 7b will be based on the PBU L-Pad site, and Problem 7c will be a down-dip version of the L-Pad site. In all three cases, a standard set of parameters will be used based on those found in Problem 6 (the history matches to the MDT data). The parameters chosen were consensus values based on the experiences of the various groups in attempting to match the MDT data for the C2 formation at Mount Elbert.

Given below are the detailed descriptions of the three problems and the proposed parameter values. All other parameters (hydration number, etc) that are not given explicitly will be those used in the previous code comparison problems.

<u>Problem Description for Problem 7a (a Mt Elbert-like formation)</u>

<u>Model Domain</u>

2-D Radial Grid System : 450 m x 152.5 m (700m + 12.5m + 700m)



Discretization

r direction : 80 cells logarithmically distributed from r_w = 0.111 m to r_{80} = 450 m (inner most grid size Δr_1 = 0.02 m). The exact r-values (at the cell boundaries) to be used are given below…

rw	0.111						
r1	0.131	**r21**	1.414	**r41**	10.287	**r61**	71.627
r2	0.153	**r22**	1.567	**r42**	11.340	**r62**	78.906
r3	0.177	**r23**	1.735	**r43**	12.500	**r63**	86.923
r4	0.204	**r24**	1.919	**r44**	13.777	**r64**	95.755
r5	0.233	**r25**	2.123	**r45**	15.184	**r65**	105.482
r6	0.266	**r26**	2.347	**r46**	16.734	**r66**	116.198
r7	0.302	**r27**	2.594	**r47**	18.442	**r67**	128.000
r8	0.341	**r28**	2.866	**r48**	20.322	**r68**	141.001
r9	0.384	**r29**	3.166	**r49**	22.394	**r69**	155.321
r10	0.432	**r30**	3.496	**r50**	24.675	**r70**	171.095
r11	0.485	**r31**	3.859	**r51**	27.188	**r71**	188.469
r12	0.543	**r32**	4.260	**r52**	29.957	**r72**	207.607
r13	0.606	**r33**	4.701	**r53**	33.006	**r73**	228.688
r14	0.677	**r34**	5.187	**r54**	36.365	**r74**	251.909
r15	0.754	**r35**	5.722	**r55**	40.065	**r75**	277.486
r16	0.839	**r36**	6.311	**r56**	44.140	**r76**	305.659
r17	0.933	**r37**	6.961	**r57**	48.629	**r77**	336.692
r18	1.037	**r38**	7.676	**r58**	53.573	**r78**	370.874
r19	1.151	**r39**	8.464	**r59**	59.020	**r79**	408.526
r20	1.276	**r40**	9.331	**r60**	65.019	**r80**	450.000

z direction : 70 cells (10 x *various* m, 50 x 0.25 m, 10 x *various* m)

While the cells in the hydrate zone are uniform in size, those in the shale have logarithmically varying thicknesses. In both shale zones, the first grid block (next to the hydrate zone) is the same size as those in the hydrate bearing zone (0.25 m). For each subsequent cell, the dz obeys $dz_i=dz_{i-1}*$ 1.694831 (as one moves away from the hydrate zome). This leads to the following z values (at boundaries and cell centers) in the shale layers (as you progress away from the hydrate layer):

Cell #	dz	z(outer boundary)	z(center)
1	0.25	0.250	0.125
2	0.42371	0.674	0.461854
3	0.71811	1.392	1.032764
4	1.21708	2.609	2.000361
5	2.06275	4.672	3.640274
6	3.496	8.168	6.419649
7	5.92514	14.093	11.13022
8	10.0421	24.135	19.11384
9	17.0197	41.155	32.64473
10	28.8455	70.000	55.5773

The full set of z-values are given below along with the initial conditions.

Initial Conditions

Pressure & Temperature

Geothermal gradient ; 35.5 K/km
Hydrostatic pressure gradient ; 9792 Pa/m

Cell	Region	Z (boundary)	Z (center)	T (boundary)	T (center)	P/Mpa (boundary)	P/MPa (center)
		0.000		273.295		6.035	
1	Shale	28.845	14.423	274.319	273.807	6.317	6.176
2	Shale	45.865	37.355	274.923	274.621	6.484	6.400
3	Shale	55.907	50.886	275.280	275.101	6.582	6.533
4	Shale	61.832	58.870	275.490	275.385	6.640	6.611
5	Shale	65.328	63.580	275.614	275.552	6.674	6.657
6	Shale	67.391	66.360	275.687	275.651	6.694	6.684
7	Shale	68.608	68.000	275.731	275.709	6.706	6.700
8	Shale	69.326	68.967	275.756	275.743	6.713	6.710
9	Shale	69.750	69.538	275.771	275.764	6.718	6.715
10	Shale	70.000	69.875	275.780	275.776	6.720	6.719
11	Hydrate	70.250	70.125	275.789	275.784	6.722	6.721
12	Hydrate	70.500	70.375	275.798	275.793	6.725	6.724
13	Hydrate	70.750	70.625	275.807	275.802	6.727	6.726
14	Hydrate	71.000	70.875	275.816	275.811	6.730	6.729
15	Hydrate	71.250	71.125	275.824	275.820	6.732	6.731
16	Hydrate	71.500	71.375	275.833	275.829	6.735	6.733
17	Hydrate	71.750	71.625	275.842	275.838	6.737	6.736
18	Hydrate	72.000	71.875	275.851	275.847	6.740	6.738
19	Hydrate	72.250	72.125	275.860	275.855	6.742	6.741
20	Hydrate	72.500	72.375	275.869	275.864	6.744	6.743
21	Hydrate	72.750	72.625	275.878	275.873	6.747	6.746
22	Hydrate	73.000	72.875	275.887	275.882	6.749	6.748
23	Hydrate	73.250	73.125	275.895	275.891	6.752	6.751
24	Hydrate	73.500	73.375	275.904	275.900	6.754	6.753
25	Hydrate	73.750	73.625	275.913	275.909	6.757	6.755
26	Hydrate	74.000	73.875	275.922	275.918	6.759	6.758
27	Hydrate	74.250	74.125	275.931	275.926	6.762	6.760
28	Hydrate	74.500	74.375	275.940	275.935	6.764	6.763
29	Hydrate	74.750	74.625	275.949	275.944	6.767	6.765
30	Hydrate	75.000	74.875	275.958	275.953	6.769	6.768
31	Hydrate	75.250	75.125	275.966	275.962	6.771	6.770
32	Hydrate	75.500	75.375	275.975	275.971	6.774	6.773
33	Hydrate	75.750	75.625	275.984	275.980	6.776	6.775
34	Hydrate	76.000	75.875	275.993	275.989	6.779	6.778
35	Hydrate	76.250	76.125	276.002	275.997	6.781	6.780
36	Hydrate	76.500	76.375	276.011	276.006	6.784	6.782
37	Hydrate	76.750	76.625	276.020	276.015	6.786	6.785

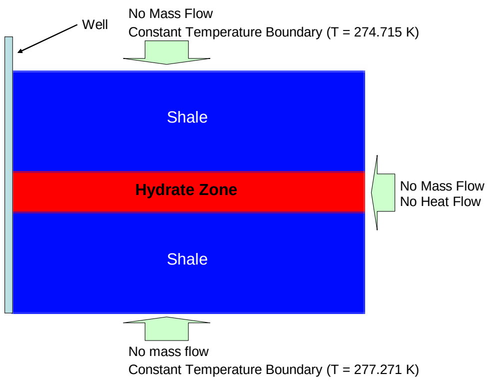
38	Hydrate	77.000	76.875	276.029	276.024	6.789	6.787
39	Hydrate	77.250	77.125	276.037	276.033	6.791	6.790
40	Hydrate	77.500	77.375	276.046	276.042	6.793	6.792
41	Hydrate	77.750	77.625	276.055	276.051	6.796	6.795
42	Hydrate	78.000	77.875	276.064	276.060	6.798	6.797
43	Hydrate	78.250	78.125	276.073	276.068	6.801	6.800
44	Hydrate	78.500	78.375	276.082	276.077	6.803	6.802
45	Hydrate	78.750	78.625	276.091	276.086	6.806	6.804
46	Hydrate	79.000	78.875	276.100	276.095	6.808	6.807
47	Hydrate	79.250	79.125	276.108	276.104	6.811	6.809
48	Hydrate	79.500	79.375	276.117	276.113	6.813	6.812
49	Hydrate	79.750	79.625	276.126	276.122	6.815	6.814
50	Hydrate	80.000	79.875	276.135	276.131	6.818	6.817
51	Hydrate	80.250	80.125	276.144	276.139	6.820	6.819
52	Hydrate	80.500	80.375	276.153	276.148	6.823	6.822
53	Hydrate	80.750	80.625	276.162	276.157	6.825	6.824
54	Hydrate	81.000	80.875	276.171	276.166	6.828	6.826
55	Hydrate	81.250	81.125	276.179	276.175	6.830	6.829
56	Hydrate	81.500	81.375	276.188	276.184	6.833	6.831
57	Hydrate	81.750	81.625	276.197	276.193	6.835	6.834
58	Hydrate	82.000	81.875	276.206	276.202	6.838	6.836
59	Hydrate	82.250	82.125	276.215	276.210	6.840	6.839
60	Hydrate	82.500	82.375	276.224	276.219	6.842	6.841
61	Shale	82.750	82.625	276.233	276.228	6.845	6.844
62	Shale	83.174	82.962	276.248	276.240	6.849	6.847
63	Shale	83.892	83.533	276.273	276.260	6.856	6.853
64	Shale	85.109	84.500	276.316	276.295	6.868	6.862
65	Shale	87.172	86.140	276.390	276.353	6.888	6.878
66	Shale	90.668	88.920	276.514	276.452	6.922	6.905
67	Shale	96.593	93.630	276.724	276.619	6.980	6.951
68	Shale	106.635	101.614	277.081	276.902	7.079	7.030
69	Shale	123.655	115.145	277.685	277.383	7.245	7.162
70	Shale	152.500	138.077	278.709	278.197	7.528	7.387

Hydrate Saturation & Water Saturation

	Methane Hydrate Saturation (%)	Water Saturation (%)
Shale Zone	0	100
Hydrate Zone	65	35

Boundary Conditions

No mass flow
Upper boundary temperature = 274.715 K (constant)
Lower boundary temperature = 277.271 K(constant)



Medium Properties

Permeability (mD)	0.0 (Shale Zone), 1000 in radial direction (Hydrate Zone), 100 in vertical (Hydrate Zone)
Porosity (%)	10 (Shale Zone), 35 (Hydrate Zone)
Pore Compressibility (1/Pa)	10^{-9}
Rock Density (kg/m^3)	2650
Rock Specific Heat (J/kg/K)	1000

Composite thermal conductivity model: nonlinear (per earlier decision)

$\kappa = \kappa_{dry} + \left(\sqrt{S_{Hyd}} + \sqrt{S_{aq}}\right)\left(\kappa_{wet} - \kappa_{dry}\right) + \phi S_{ice}\kappa_{ice}$; $\kappa_{dry} = 1.0$ (W/m/K), $\kappa_{wet} = 3.1$ (W/m/K),
$\kappa_{ice} =$ Not relevant to this problem

Relative Permeability

It should be noted that we discussed in detail the form of the relative permeability functions to be used. It was noted that the form given below is consistent with those used by TOUGH, MH21, and STOMP. It appears that this form of the rel perm is NOT consistent with the formulation of STARS when hydrate is considered to be a "solid". It should be possible to match this form with the previous formulation (when hydrate is considered to be an immobile, viscous liquid). The consensus was that it made the most sense to use the formulation given below. STARS can utilize the "viscous liquid" formulation for modeling hydrate. If a way is found to also match this rel perm using the solid formulation, another set of runs can be done to compare the results of the two formulations when everything else is consistent.

Water Relative Permeability

$$k_{rw} = \left\{ \frac{(S_W - S_{Wir})}{(1 - S_{Wir})} \right\}^{4.52}$$; $S_{Wir} = 0.248$ (This yields a $k_{eff} = 0.12$ mD)

Gas Relative Permeability

$$k_{rg} = \left\{ \frac{(S_G - S_{Gir})}{(1 - S_{Wir})} \right\}^{3.16}$$ $S_{Wir} = 0.$ $SG_{ir} = 0.$

Capillary Pressure

$$\bar{s}_l = \frac{(s_l - s_{lr})}{(1 - s_{lr})} = \left(1 - \left(\alpha\ \beta_{gl} \left\{ \frac{(P_g - P_l)}{\rho_l\ g} \right\} \right)^n \right)^{-m} :$$

$\alpha = 10.204$ 1/m, $\beta_{gl} = 1.0$, $n = 4.432$, $m = 0.7744$, $s_{lr} = 0.28$

***Salinity** is ignored*

***Methane solubility** is included in those models that use this as a variable, and is neglected in those that do not (STARS).*

Well Information

Wellbore Radius = 0.111 m
Bottomhole Flowing Pressure = 2.7 MPa (constant); this was chosen so that the pressure would remain above the quadruple point pressure to keep ice from forming in the system

Time Frame

50 years. The simulations will be run until either 50 years is reached, or the reservoir produces all of the available fluids.

Data to be compared

gas production rate, water production rate, cumulative gas production, cumulative water production

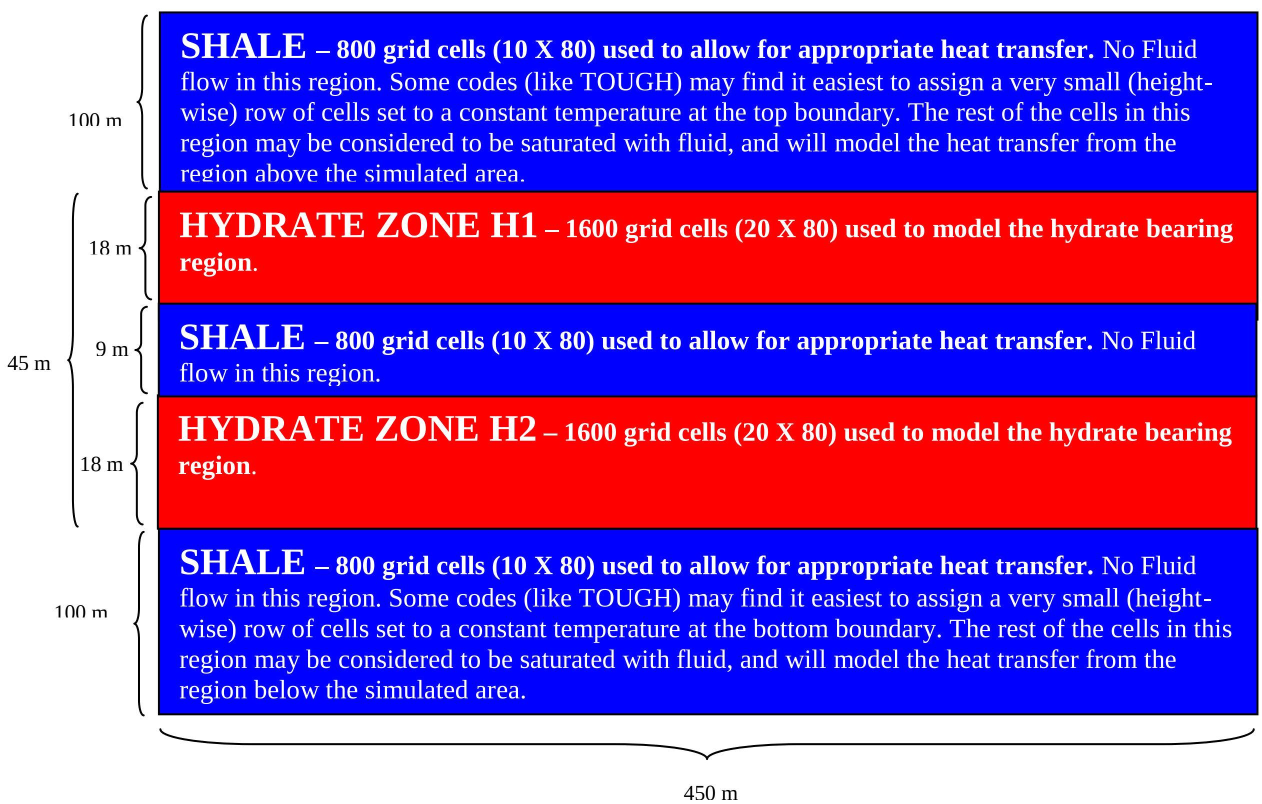
Sampling Frequency

Every 90 days (production rate, cumulative production)

Problem 7b: PBU L-Pad

Information we have about the reservoir (Provided by T. Collett):
Assume uniform reservoir
–Two shale bounded hydrate layers: (1) 2226-2288 ft, (2) 2318-2374 ft
–Gas Hydrate Saturation 75% (constant)
–Porosity 40% (constant)
–Permeability (intrinsic) 1,000 mD
–Reservoir Temp, regional gradient data: 5.0-6.5 °C
–Pore water salinities 5 ppt

All parameters and conditions will be the same as those for Problem 7a except those that need to be modified to be consistent with the above data. Below is the description that will be used for this problem.



Discretization

r direction : 80 cells logarithmically distributed from $r_w = 0.111$ m to $r_{80} = 450$ m (inner most grid size $\Delta r_1 = 0.02$ m)

--- THIS PROBLEM USES THE SAME RADIAL GRIDS AS PROBLEM 7a) ---

z direction : 70 cells (10 x *various* m, 50 x 0.9 m, 10 x *various* m)

While the cells in (and between) the hydrate zones are uniform in size, those in the uppermost and lowermost shale zones have logarithmically varying thicknesses. In both of these shale zones, the first grid block (next to the hydrate zone) is the same size as those in the hydrate bearing zone (0.9 m). For each subsequent cell, the dz obeys $dz_i = dz_{i-1} * 1.49587$ (as one moves away from the hydrate zome). This leads to the following z values (at boundaries and cell centers) in the shale layers (as you progress away from the hydrate layer):

Cell #	dz	z (boundary)	z (center)
1	0.9	0.900	0.450
2	1.346283	2.246	1.573
3	2.013864	4.260	3.253
4	3.012479	7.273	5.766
5	4.506277	11.779	9.526
6	6.740805	18.520	15.149
7	10.08337	28.603	23.561
8	15.08341	43.686	36.145
9	22.56282	66.249	54.968
10	33.75104	100.000	83.125

Initial Conditions

Pressure & Temperature

Geothermal gradient ; (1.5 K)/(45 m) = 0.03 K/m
Hydrostatic pressure gradient ; 9792 Pa/m

The top of the first hydrate bearing zone (zone H1) is approximately 62 meters below the top of the hydrate bering zone in Problem 7a, so the pressure at the top of zone H1 will be 6.72 MPa + 0.009792*62 = 7.327 MPa. Using this and that the temperature at this point is 278.15 K (see above) we have:

Cell	Region	Z (boundary)	Z (center)	T (boundary)	T (center)	P/Mpa (boundary)	P/MPa (center)
		0.000		275.150		6.348	
1	Shale	33.751	16.875	276.163	275.656	6.678	6.513
2	Shale	56.314	45.032	276.839	276.501	6.899	6.789
3	Shale	71.397	63.855	277.292	277.066	7.047	6.973
4	Shale	81.480	76.439	277.594	277.443	7.146	7.096
5	Shale	88.221	84.851	277.797	277.696	7.212	7.179
6	Shale	92.727	90.474	277.932	277.864	7.256	7.234
7	Shale	95.740	94.234	278.022	277.977	7.285	7.271
8	Shale	97.754	96.747	278.083	278.052	7.305	7.295
9	Shale	99.100	98.427	278.123	278.103	7.318	7.312
10	Shale	100.000	99.550	278.150	278.137	7.327	7.323
11	Hydrate	100.900	100.450	278.177	278.164	7.336	7.331
12	Hydrate	101.800	101.350	278.204	278.191	7.345	7.340
13	Hydrate	102.700	102.250	278.231	278.218	7.353	7.349
14	Hydrate	103.600	103.150	278.258	278.245	7.362	7.358
15	Hydrate	104.500	104.050	278.285	278.272	7.371	7.367
16	Hydrate	105.400	104.950	278.312	278.299	7.380	7.375
17	Hydrate	106.300	105.850	278.339	278.326	7.389	7.384
18	Hydrate	107.200	106.750	278.366	278.353	7.398	7.393
19	Hydrate	108.100	107.650	278.393	278.380	7.406	7.402
20	Hydrate	109.000	108.550	278.420	278.407	7.415	7.411
21	Hydrate	109.900	109.450	278.447	278.434	7.424	7.420
22	Hydrate	110.800	110.350	278.474	278.461	7.433	7.428
23	Hydrate	111.700	111.250	278.501	278.488	7.442	7.437
24	Hydrate	112.600	112.150	278.528	278.515	7.450	7.446
25	Hydrate	113.500	113.050	278.555	278.542	7.459	7.455
26	Hydrate	114.400	113.950	278.582	278.569	7.468	7.464
27	Hydrate	115.300	114.850	278.609	278.596	7.477	7.472
28	Hydrate	116.200	115.750	278.636	278.623	7.486	7.481
29	Hydrate	117.100	116.650	278.663	278.650	7.494	7.490
30	Hydrate	118.000	117.550	278.690	278.677	7.503	7.499
31	Shale	118.900	118.450	278.717	278.704	7.512	7.508
32	Shale	119.800	119.350	278.744	278.731	7.521	7.516

33	Shale	120.700	120.250	278.771	278.758	7.530	7.525
34	Shale	121.600	121.150	278.798	278.785	7.539	7.534
35	Shale	122.500	122.050	278.825	278.812	7.547	7.543
36	Shale	123.400	122.950	278.852	278.839	7.556	7.552
37	Shale	124.300	123.850	278.879	278.866	7.565	7.561
38	Shale	125.200	124.750	278.906	278.893	7.574	7.569
39	Shale	126.100	125.650	278.933	278.920	7.583	7.578
40	Shale	127.000	126.550	278.960	278.947	7.591	7.587
41	Hydrate	127.900	127.450	278.987	278.974	7.600	7.596
42	Hydrate	128.800	128.350	279.014	279.001	7.609	7.605
43	Hydrate	129.700	129.250	279.041	279.028	7.618	7.613
44	Hydrate	130.600	130.150	279.068	279.055	7.627	7.622
45	Hydrate	131.500	131.050	279.095	279.082	7.635	7.631
46	Hydrate	132.400	131.950	279.122	279.109	7.644	7.640
47	Hydrate	133.300	132.850	279.149	279.136	7.653	7.649
48	Hydrate	134.200	133.750	279.176	279.163	7.662	7.657
49	Hydrate	135.100	134.650	279.203	279.190	7.671	7.666
50	Hydrate	136.000	135.550	279.230	279.217	7.680	7.675
51	Hydrate	136.900	136.450	279.257	279.244	7.688	7.684
52	Hydrate	137.800	137.350	279.284	279.271	7.697	7.693
53	Hydrate	138.700	138.250	279.311	279.298	7.706	7.702
54	Hydrate	139.600	139.150	279.338	279.325	7.715	7.710
55	Hydrate	140.500	140.050	279.365	279.352	7.724	7.719
56	Hydrate	141.400	140.950	279.392	279.379	7.732	7.728
57	Hydrate	142.300	141.850	279.419	279.406	7.741	7.737
58	Hydrate	143.200	142.750	279.446	279.433	7.750	7.746
59	Hydrate	144.100	143.650	279.473	279.460	7.759	7.754
60	Hydrate	145.000	144.550	279.500	279.487	7.768	7.763
61	Shale	145.900	145.450	279.527	279.514	7.776	7.772
62	Shale	147.246	146.573	279.567	279.547	7.790	7.783
63	Shale	149.260	148.253	279.628	279.598	7.809	7.799
64	Shale	152.273	150.766	279.718	279.673	7.839	7.824
65	Shale	156.779	154.526	279.853	279.786	7.883	7.861
66	Shale	163.520	160.149	280.056	279.954	7.949	7.916
67	Shale	173.603	168.561	280.358	280.207	8.048	7.998
68	Shale	188.686	181.145	280.811	280.584	8.195	8.122
69	Shale	211.249	199.968	281.487	281.149	8.416	8.306
70	Shale	245.000	228.125	282.500	281.994	8.747	8.582

Hydrate Saturation & Water Saturation

	Methane Hydrate Saturation (%)	Water Saturation (%)
Shale Zones	0	100
Hydrate Zones	75	25

Boundary Conditions

No mass flow

Upper boundary temperature = 275.15 K (constant)

Lower boundary temperature = 282.50 K(constant)

Medium Properties

Permeability (mD)	0.0 (Shale Zone), 1000 in radial direction (Hydrate Zones), 100 in vertical (Hydrate Zones)
Porosity (%)	10 (Shale Zone), 40 (Hydrate Zones)
Pore Compressibility (1/Pa)	10^{-9}
Rock Density (kg/m³)	2650
Rock Specific Heat (J/kg/K)	1000

Composite thermal conductivity model: nonlinear (per earlier decision)

$\kappa = \kappa_{dry} + \left(\sqrt{S_{Hyd}} + \sqrt{S_{aq}}\right)\left(\kappa_{wet} - \kappa_{dry}\right) + \phi S_{ice}\kappa_{ice}$; $\kappa_{dry} = 1.0$ (W/m/K), $\kappa_{wet} = 3.1$ (W/m/K),

$\kappa_{ice} =$ Not applicable in this problem

Relative Permeability

Water Relative Permeability

$$k_{rw} = \left\{\frac{(S_W - S_{Wir})}{(1 - S_{Wir})}\right\}^{5.04}$$; $S_{Wir} = 0.10$ (This yields a $k_{eff} = 0.12$ mD)

Gas Relative Permeability

$$k_{rg} = \left\{\frac{(S_G - S_{Gir})}{(1 - S_{Wir})}\right\}^{3.16}$$ $S_{Wir} = 0.$ $SG_{ir} = 0.$

Capillary Pressure

$$\bar{s}_l = \frac{(s_l - s_{lr})}{(1 - s_{lr})} = \left(1 - \left(\alpha\ \beta_{gl} \left\{\frac{(P_g - P_l)}{\rho_l\ g}\right\}\right)^n\right)^{-m} :$$

$\alpha = 10.204$ 1/m , $\beta_{gl} = 1.0$, $n = 4.432$, $m = 0.7744$, $s_{lr} = 0.28$

Salinity is ignored
Methane solubility is included in those models that use this as a variable, and is neglected in those that do not (STARS).

Well Information

Wellbore Radius = 0.111 m (completed over the 45 m containing hydrate zones H1 and H2)

Bottomhole Flowing Pressure = 2.7 MPa (constant); this was chosen so that the pressure would remain above the quadruple point pressure to keep ice from forming in the system

Time Frame

50 years. The simulations will be run until either 50 years is reached, or the reservoir produces all of the available fluids.

Data to be compared
gas production rate, water production rate, cumulative gas production, cumulative water production

Sampling Frequency
Every 90 days (production rate, cumulative production)

Problem 7c: Down-dip PBU L-Pad

Information we have about the reservoir (Provided by T. Collett):
Same Unit as above, down dip to the east, base of gas hydrate stability zone about 2,700 ft and 12°C

All parameters and conditions will be the same as those for Problems 7a&b except those that need to be modified to be consistent with the above data (ie., the initial temperatures and pressures).

Boundary Conditions

No mass flow
Upper boundary temperature = 280.80 K (constant)
Lower boundary temperature = 288.15 K(constant)

Initial Conditions

If we want the bottom of the hydrate bearing zone to be at 12 degrees C and be at the base of the hydrate stability zone, then the pressure must be near the hydrate equilibrium pressure for 12 degrees C, which is approximately 8.98 MPa. Therefore, assume base of hydrate bearing layers is at 12 degrees C and 9.1 MPa. Using these constraints, the initial temperatures and pressures need to be modified as shown below:

Cell	Region	Z (boundary)	Z (center)	T (boundary)	T (center)	P/Mpa (boundary)	P/MPa (center)
		0.000		280.800		7.680	
1	Shale	33.751	16.875	281.813	281.306	8.011	7.845
2	Shale	56.314	45.032	282.489	282.151	8.232	8.121
3	Shale	71.397	63.855	282.942	282.716	8.379	8.305
4	Shale	81.480	76.439	283.244	283.093	8.478	8.429
5	Shale	88.221	84.851	283.447	283.346	8.544	8.511
6	Shale	92.727	90.474	283.582	283.514	8.588	8.566
7	Shale	95.740	94.234	283.672	283.627	8.618	8.603
8	Shale	97.754	96.747	283.733	283.702	8.637	8.628
9	Shale	99.100	98.427	283.773	283.753	8.651	8.644
10	Shale	100.000	99.550	283.800	283.787	8.659	8.655
11	Hydrate	100.900	100.450	283.827	283.814	8.668	8.664
12	Hydrate	101.800	101.350	283.854	283.841	8.677	8.673
13	Hydrate	102.700	102.250	283.881	283.868	8.686	8.681
14	Hydrate	103.600	103.150	283.908	283.895	8.695	8.690
15	Hydrate	104.500	104.050	283.935	283.922	8.703	8.699
16	Hydrate	105.400	104.950	283.962	283.949	8.712	8.708
17	Hydrate	106.300	105.850	283.989	283.976	8.721	8.717
18	Hydrate	107.200	106.750	284.016	284.003	8.730	8.725
19	Hydrate	108.100	107.650	284.043	284.030	8.739	8.734
20	Hydrate	109.000	108.550	284.070	284.057	8.747	8.743
21	Hydrate	109.900	109.450	284.097	284.084	8.756	8.752
22	Hydrate	110.800	110.350	284.124	284.111	8.765	8.761

23	Hydrate	111.700	111.250	284.151	284.138	8.774	8.770
24	Hydrate	112.600	112.150	284.178	284.165	8.783	8.778
25	Hydrate	113.500	113.050	284.205	284.192	8.792	8.787
26	Hydrate	114.400	113.950	284.232	284.219	8.800	8.796
27	Hydrate	115.300	114.850	284.259	284.246	8.809	8.805
28	Hydrate	116.200	115.750	284.286	284.273	8.818	8.814
29	Hydrate	117.100	116.650	284.313	284.300	8.827	8.822
30	Hydrate	118.000	117.550	284.340	284.327	8.836	8.831
31	Shale	118.900	118.450	284.367	284.354	8.844	8.840
32	Shale	119.800	119.350	284.394	284.381	8.853	8.849
33	Shale	120.700	120.250	284.421	284.408	8.862	8.858
34	Shale	121.600	121.150	284.448	284.435	8.871	8.866
35	Shale	122.500	122.050	284.475	284.462	8.880	8.875
36	Shale	123.400	122.950	284.502	284.489	8.888	8.884
37	Shale	124.300	123.850	284.529	284.516	8.897	8.893
38	Shale	125.200	124.750	284.556	284.543	8.906	8.902
39	Shale	126.100	125.650	284.583	284.570	8.915	8.911
40	Shale	127.000	126.550	284.610	284.597	8.924	8.919
41	Hydrate	127.900	127.450	284.637	284.624	8.933	8.928
42	Hydrate	128.800	128.350	284.664	284.651	8.941	8.937
43	Hydrate	129.700	129.250	284.691	284.678	8.950	8.946
44	Hydrate	130.600	130.150	284.718	284.705	8.959	8.955
45	Hydrate	131.500	131.050	284.745	284.732	8.968	8.963
46	Hydrate	132.400	131.950	284.772	284.759	8.977	8.972
47	Hydrate	133.300	132.850	284.799	284.786	8.985	8.981
48	Hydrate	134.200	133.750	284.826	284.813	8.994	8.990
49	Hydrate	135.100	134.650	284.853	284.840	9.003	8.999
50	Hydrate	136.000	135.550	284.880	284.867	9.012	9.007
51	Hydrate	136.900	136.450	284.907	284.894	9.021	9.016
52	Hydrate	137.800	137.350	284.934	284.921	9.029	9.025
53	Hydrate	138.700	138.250	284.961	284.948	9.038	9.034
54	Hydrate	139.600	139.150	284.988	284.975	9.047	9.043
55	Hydrate	140.500	140.050	285.015	285.002	9.056	9.052
56	Hydrate	141.400	140.950	285.042	285.029	9.065	9.060
57	Hydrate	142.300	141.850	285.069	285.056	9.074	9.069
58	Hydrate	143.200	142.750	285.096	285.083	9.082	9.078
59	Hydrate	144.100	143.650	285.123	285.110	9.091	9.087
60	Hydrate	145.000	144.550	285.150	285.137	9.100	9.096
61	Shale	145.900	145.450	285.177	285.164	9.109	9.104
62	Shale	147.246	146.573	285.217	285.197	9.122	9.115
63	Shale	149.260	148.253	285.278	285.248	9.142	9.132
64	Shale	152.273	150.766	285.368	285.323	9.171	9.156
65	Shale	156.779	154.526	285.503	285.436	9.215	9.193
66	Shale	163.520	160.149	285.706	285.604	9.281	9.248
67	Shale	173.603	168.561	286.008	285.857	9.380	9.331
68	Shale	188.686	181.145	286.461	286.234	9.528	9.454
69	Shale	211.249	199.968	287.137	286.799	9.749	9.638
70	Shale	245.000	228.125	288.150	287.644	10.079	9.914