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APPENDICES

APPENDIX A

Sequential Gaussian Simulation

A-1) Load ObjectObject Type

- Select object type	point set
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Additional Parameters

- Pointset name	Data
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Points Coordinates

- Col. # for X coordinates	1
- Col. # for Y coordinates	2
- Col. # for Z coordinates	3

A-2) Create New Cartesian Grid

<u>Grid name</u>	Grid
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Grid Dimensions

- Number of cells in X	100
- Number of cells in Y	100
- Number of cells in Z	300 (for K2 layer)
	600 (for K3 layer)

Cell Size

The dimensions of a single cell

- Size in X	30
- Size in Y	30
- Size in Z	1 (for K2 layer)
	0.5 (for K3 layer)

Origin Coordinates

The coordinates of the lowest left corner of the grid

- 0x	591,500
- 0y	1,840,200
- 0z	1,400 (for K2 layer)
	1,500 (for K3 layer)

A-3) GeneralSimulation Grid

- Simulation Grid Name	Grid
- Property Name Prefix	SGS
- Nb of realizations	16
- Seed	14,071,789
- Kriging Type	Simple Kriging (SK)

A-4) DataHard Data

- Object	Data
- Property	Porosity

Search Ellipsoid

- Max conditioning data	12
- Range (Max, Med and Min)	1,302 (for K2 layer)
	820 (for K3 layer)
- Angles	
Azimuth	0
Dip	90
Rake	0

Target Histogram

Use Target Histogram

- Reference distribution from:	From Object
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Property with ref. distribution

- Object	Data
- Property	Porosity
Lower Tail Extrapolation	
- Function	Power
- Min	0.10 (for K2 layer)
	0.09 (for K3 layer)
- omega	3
Upper Tail Extrapolation	
- Function	Power
- Max	0.3
- omega	0.333

A-5) VariogramVariogram

- Nugget Effect	0.0005 (for K2 layer)
	0.0002 (for K3 layer)
- Nb of Structures	1
- Contribution	0.0013 (for K2 layer)
	0.0016 (for K3 layer)
- Type	Gaussian (for K2 layer)
	Spherical (for K3 layer)
- Range (Max, Med and Min)	1,302 (for K2 layer)
	820 (for K3 layer)
- Angles	
Azimuth	0
Dip	90
Rake	0

APPENDIX B

B-1) Case Definition

The reservoir model is generated by input the required data in Eclipse simulation program.

General

- Simulator Black Oil
- Simulation Start Date 1 SEP 2007
- Select Model Dimensions
 - No. of cells in X direction 30
 - No. of cells in Y direction 30
 - No. of cells in Z direction 7

Reservoir

- Grid option
 - Grid type Cartesian
- Geometry option
 - Geometry type Block Centered

PVT

- Oil-Gas-Water Properties Water, Oil and Dissolved Gas

B-2) GridGrid Keyword Section

- Properties

Permeability X (mD)	658	in layer 1 of case I
	772	in layer 1 of case II
	2,420	in layer 2 of case I
	3,800	in layer 2 of case II
	51	in layer 3 of case I
	51	in layer 3 of case II
	2,100	in layer 4 of case I
	2,053	in layer 4 of case II
	553	in layer 5 of case I
	550	in layer 5 of case II
	1,760	in layer 6 of case I
	1,827	in layer 6 of case II
	2,560	in layer 7 of case I
	1,605	in layer 7 of case II
Permeability Y (mD)	Same as Permeability X	
Permeability Z (mD)	0.1*Permeability X	
Porosity	0.258	in layer 1 of case I
	0.191	in layer 1 of case II
	0.281	in layer 2 of case I
	0.210	in layer 2 of case II
	0.219	in layer 3 of case I
	0.217	in layer 3 of case II
	0.264	in layer 4 of case I
	0.176	in layer 4 of case II
	0.243	in layer 5 of case I
	0.173	in layer 5 of case II
	0.264	in layer 6 of case I
	0.170	in layer 6 of case II
	0.269	in layer 7 of case I
	0.164	in layer 7 of case II

- Geometry

Grid Data Units	Feet
X Grid Block Sizes	328.1
Y Grid Block Sizes	328.1
Z Grid Block Sizes	16.6 in layer 1
	18.7 in layer 2
	32.2 in layer 3
	33.5 in layer 4
	1.3 in layer 5
	1.6 in layer 6
	3.0 in layer 7
Depths of Top Faces	5,300.0 in layer 1
	5,316.6 in layer 2
	5,335.3 in layer 3
	5,367.5 in layer 4
	5,401.0 in layer 5
	5,402.3 in layer 6
	5,403.9 in layer 7

B-3) PVTPVT Keyword Section

- Water PVT Properties

Reference Pressure (Pref)	3,200 psia
Water FVF at Pref	1.0223 rb/stb
Water Compressibility	3.5E-6 /psi
Water Viscosity at Pref	0.3 cp
Water Viscosity	0 /psi

- Live Oil PVT Properties (Dissolved Gas)

Rs (Mscf/stb)	P _{bub} (psia)	FVF (rb /stb)	Visc (cp)
0.03	192.00	1.1363	1.7259
	445.05	1.1336	1.7666
	698.11	1.1309	1.8074
	951.16	1.1282	1.8481
	1,204.20	1.1255	1.8889
	1,457.30	1.1228	1.9296
	1,710.30	1.1201	1.9704
	1,963.40	1.1174	2.0111
	2,216.40	1.1147	2.0518
	2,469.50	1.1120	2.0926
	2,722.50	1.1093	2.1333
	2,975.60	1.1066	2.1741
	3,228.60	1.1039	2.2148
	3,481.70	1.1012	2.2555
	3,734.70	1.0985	2.2963
	3,987.80	1.0958	2.3370
	4,240.80	1.0931	2.3778
	4,493.90	1.0904	2.4185
	4,746.90	1.0877	2.4593
	5,000.00	1.0850	2.5000
0.15	575.00	1.1675	1.4000
	807.89	1.1650	1.4368
	1,040.80	1.1625	1.4737
	1,273.70	1.1600	1.5105
	1,506.60	1.1575	1.5474
	1,739.50	1.1550	1.5842
	1,972.40	1.1525	1.6211
	2,205.30	1.1500	1.6579
	2,438.20	1.1475	1.6947
	2,671.10	1.1450	1.7316
	2,903.90	1.1425	1.7684
	3,136.80	1.1400	1.8053
	3,369.70	1.1375	1.8421
	3,602.60	1.1350	1.8789
	3,835.50	1.1325	1.9158
	4,068.40	1.1300	1.9526
	4,301.30	1.1275	1.9895
4,534.20	1.1250	2.0263	

- Live Oil PVT Properties (Dissolved Gas) (continued)

Rs (Mscf/stb)	P _{bub} (psia)	FVF (rb /stb)	Visc (cp)
0.15	4,767.10	1.1225	2.0632
	5,000.00	1.1200	2.1000
0.215	928.00	1.1950	1.2300
	1,142.30	1.1924	1.2679
	1,356.60	1.1897	1.3058
	1,570.90	1.1871	1.3437
	1,785.30	1.1845	1.3816
	1,999.60	1.1818	1.4195
	2,213.90	1.1792	1.4574
	2,428.20	1.1766	1.4953
	2,642.50	1.1739	1.5332
	2,856.80	1.1713	1.5711
	3,071.20	1.1687	1.6089
	3,285.50	1.1661	1.6468
	3,499.80	1.1634	1.6847
	3,714.10	1.1608	1.7226
	3,928.40	1.1582	1.7605
	4,142.70	1.1555	1.7984
	4,357.10	1.1529	1.8363
	4,571.40	1.1503	1.8742
	4,785.70	1.1476	1.9121
5,000.00	1.1450	1.9500	
0.28	1,281.00	1.2250	1.1250
	1,476.70	1.2229	1.1579
	1,672.50	1.2208	1.1908
	1,868.20	1.2187	1.2237
	2,063.90	1.2166	1.2566
	2,259.70	1.2145	1.2895
	2,455.40	1.2124	1.3224
	2,651.20	1.2103	1.3553
	2,846.90	1.2082	1.3882
	3,042.60	1.2061	1.4211
	3,238.40	1.2039	1.4539
	3,434.10	1.2018	1.4868
	3,629.80	1.1997	1.5197
	3,825.60	1.1976	1.5526
	4,021.30	1.1955	1.5855
4,217.10	1.1934	1.6184	

- Live Oil PVT Properties (Dissolved Gas) (continued)

Rs (Mscf/stb)	P _{pub} (psia)	FVF (rb /stb)	Visc (cp)
0.280	4,412.80	1.1913	1.6513
0.280	4,608.50	1.1892	1.6842
0.280	4,804.30	1.1871	1.7171
0.280	5,000.00	1.1850	1.7500
0.296	1,341.00	1.2300	1.1094
0.296	1,533.60	1.2279	1.1392
0.296	1,726.20	1.2258	1.1689
0.296	1,918.70	1.2237	1.1987
0.296	2,111.30	1.2216	1.2285
0.296	2,303.90	1.2195	1.2582
0.296	2,496.50	1.2174	1.288
0.296	2,689.10	1.2153	1.3178
0.296	2,881.60	1.2132	1.3475
0.296	3,074.20	1.2111	1.3773
0.296	3,266.80	1.2089	1.4071
0.296	3,459.40	1.2068	1.4369
0.296	3,651.90	1.2047	1.4666
0.296	3,844.50	1.2026	1.4964
0.296	4,037.10	1.2005	1.5262
0.296	4,229.70	1.1984	1.5559
0.296	4,422.30	1.1963	1.5857
0.296	4,614.80	1.1942	1.6155
0.296	4,807.40	1.1921	1.6452
0.296	5,000.00	1.1900	1.6750

- Dry Gas PVT Properties (No Vapourised Oil)

Press (psia)	FVF (rb /Mscf)	Visc (cp)
0	173.82000	0.01100
90	31.12600	0.01165
200	15.10300	0.01240
400	7.68360	0.01315
600	5.10370	0.01360
725	4.22870	0.01365
950	3.15790	0.01418
1,175	2.50330	0.01480
1,400	2.06520	0.01549
1,625	1.75420	0.01628
1,850	1.52450	0.01714
2,075	1.34990	0.01807

- Dry Gas PVT Properties (No Vapourised Oil) (continued)

Press (psia)	FVF (rb /Mscf)	Visc (cp)
2,300	1.21440	0.01906
2,525	1.10730	0.02010
2,750	1.02150	0.02116
2,975	0.95178	0.02225
3,200	0.89446	0.02334
3,425	0.84676	0.02442
3,650	0.80660	0.02550
3,875	0.77244	0.02656
4,100	0.74307	0.02761
4,325	0.71758	0.02863
4,550	0.69526	0.02963
4,775	0.67556	0.03061
5,000	0.65805	0.03157

- Fluid Gravities at Surface Conditions

Oil density	51.51 lb/ft ³
Water density	62.5 lb/ft ³
Gas density	0.06 lb/ft ³

- Rock Properties

Reference Pressure	2,500 psia
Rock Compressibility	3.5E-6 /psi

B-4) SCALSaturation 1

- Water/Oil Saturation Functions

S_w	K_{rw}	K_{ro}	P_c (psia)
0	0	0.9	10000
0.04546	0	0.9	2557.3
0.09091	0	0.9	653.97
0.13636	0	0.9	167.24
0.18182	0	0.9	42.768
0.22727	0	0.9	10.937
0.27273	0	0.9	2.7969
0.31818	0	0.9	0.71526
0.35	0	0.9	0.34262
0.36364	5.19E-05	0.85488	0.18291

- Water/Oil Saturation Functions

S_w	K_{rw}	K_{ro}	P_c (psia)
0.37333	8.89E-05	0.82279	0.15387
0.39667	0.000711	0.74722	0.083986
0.40909	0.00161	0.7079	0.046776
0.42	0.0024	0.67338	0.038421
0.44333	0.005689	0.60136	0.020549
0.45455	0.008294	0.56769	0.011962
0.46667	0.011111	0.53128	0.009588
0.49	0.0192	0.46328	0.005018
0.5	0.024038	0.43509	0.003059
0.51333	0.030489	0.3975	0.002391
0.53667	0.045511	0.33416	0.001223
0.54545	0.052776	0.3113	0.000782
0.56	0.0648	0.27348	0.000596
0.58333	0.088889	0.21577	0.000297
0.59091	0.098442	0.19813	0.0002
0.60667	0.11831	0.16144	0.000148
0.63	0.1536	0.11107	7.20E-05
0.63636	0.16497	0.098656	5.12E-05
0.65333	0.19529	0.065564	3.69E-05
0.67667	0.24391	0.026627	1.74E-05
0.68182	0.25629	0.020748	1.31E-05
0.7	0.3	2.60E-21	9.19E-06
0.72727	0.35477	2.36E-21	3.35E-06
0.77273	0.44605	1.97E-21	8.56E-07
0.81818	0.53733	1.57E-21	2.19E-07
0.86364	0.62861	1.18E-21	5.60E-08
0.90909	0.71989	7.87E-22	1.43E-08
0.95455	0.81117	3.94E-22	3.66E-09
1	0.90245	0	9.36E-10

- Gas/Oil Saturation Functions

S_g	K_{rg}	K_{ro}	P_c (psia)
0	0	0.9	0
0.05	0	0.73657	0
0.071429	0.000182	0.66892	0
0.092857	0.001458	0.60281	0
0.11429	0.00492	0.53834	0
0.13571	0.011662	0.4756	0

- Gas/Oil Saturation Functions

S_g	K_{rg}	K_{ro}	P_c (psia)
0.15714	0.022777	0.41473	0
0.17857	0.039359	0.35585	0
0.2	0.0625	0.29914	0
0.22143	0.093294	0.24482	0
0.24286	0.13284	0.19316	0
0.26429	0.18222	0.14452	0
0.28571	0.24253	0.099427	0
0.30714	0.31487	0.058693	0
0.32857	0.40033	0.023837	0
0.35	0.5	0	0
0.65	1	0	0

B-5) Initialization

Initialization Keyword Section

- Initial Pressure v Depth

Depth (ft)	Pressure (psia)
5,300	2,252.570
5,350	2,272.505
5,370	2,280.479
5,400	2,292.440
5,450	2,312.375
5,470	2,320.349
5,490	2,328.323
5,500	2,332.310

- Initial Gas Saturation 0
- Initial Water Saturation 0.37
- Initial R_s 0.5 Mscf/stb

B-6) ScheduleEvents -All**-Well Specification (Well X02)**

Well	Well X02
Group	1
I Location	15
J Location	15
Datum Depth	5,300 ft
Preferred Phase	Oil
Inflow Equation	STD
Automatic Shut-In Instruction	SHUT
Crossflow	YES
Density Calculation	SEG

- Well Connection Data (Well X02)

Well	Well X02
I Location	15
J Location	15
K Upper	1
K Lower	7
Open/Shut Flag	Open
Well Bore ID	0.66 ft
Direction	Z

- Production Well Control (Well X02)

Well	Well X02
Open/Shut Flag	Open
Control	ORAT
Oil Rate	7,000 stb/day
BHP Target	100 psia

- Production Well Economic Limits (Well X02)

Well	Well X02
Minimum Oil Rate	20 stb/day
Maximum Water Cut	0.9 stb/stb
Workover Procedure	None
End Run	No
Quantity for Economic Limit	Rate
Secondary Workover Procedure	None

- Print File Output Control

Restarts	Every Report
FIP Reports	+ Balance Sheet
VFP Tables	No VFP Table Output

VITAE

Jantakan Srisuriyon was born on May 22, 1981 in Bangkok, Thailand. She received her B.Eng. in Production Engineering from the Faculty of Engineering, King Mongkut's University of Technology Thonburi in 2003. After graduating, she worked for the Toyota Motor Thailand company for 2 years and then continued her studies in the Master of Petroleum Engineering program at the Department of Mining and Petroleum Engineering, Faculty of Engineering, Chulalongkorn University.