CPE 651 : Undergraduate Summer Research

CMG Simulation Modeling Learning

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Project Outline

- □ Project Objective
- Raw Data
- □ History Matching Procedures and Results
- □ Future Forecast
- Locations of New Wells to Optimize

Project Objective

- History Matching for the Gas Field at Kansas Hugoton Flower Area.
- Future Prediction
- Determine the optimum locations for at least two new wells

Hugoton-Panoma Gas Field



Initial Reservoir Condition

Gas Saturation 2015-01-01



The reservoir interested has 24x24 blocks in the X and Y directions and has 25 layers, single porosity. There are 29 wells and had been perforated at different time.



Group	Formation / Member	LAYER
	HRNGTN	1
	KRIDER	2
	ODELL	3
	WINF	4
	GAGE	5
Chase	TOWANDA	6
	HOLMESVILLE	7
	FT RILEY	8
	L/FT RILEY	9
	MATFIELD	10
	WREFORD	11
	A1_SH	12
	A1_LM	13
	B1_SH	14
	B1_LM	15
	B2_SH	16
	B2_LM	17
Council Crovo	B3_SH	18
Council Grove	B3_LM	19
	B4_SH	20
	B4_LM	21
	B5_SH	22
	B5_LM	23
	C_SH	24
	C_LM	25

Table 1: Chase and Council Grove settings

Data Given



Table 2: Rock compressibility

Property	Value		
Reference pressure	465	psi	
Rock compressibility	0.000002	1/psi	(assumed)

Table 3: PVT properties of the Hugoton gas field

Property	Value	
Reference pressure	465	psi
Max Pressure	500	psi
Reservoir temp	90	F
Gas gravity (Air = 1.0)	0.715	
Water salinity	110,000	ppm

Builder - [producersadded_layer11.dat:1] File Edit View IO Control Reservoir Componen | 🗋 📽 🔚 🛍 🗠 🞒 👌 昌 / 🔀 🖌 Plan IJ-2D Areal Block Fill Grid Top Model Tree View • 4 × ✓ I/O Control • V Reservoir . ✓ Components • ✓ Rock-Fluid . Initial Conditions . Numerical ✓ Wells & Recurrent . 🕀 🖌 Grid Array Properties Rock-Fluid End-Point Property Modification Sectors ---- Aquifers Lease Planes - Rock Compressibility. Compaction/Dilation Regions . Options Flux Sectors

the second se	
✓ Components	Viscosity vs P
✓ Rock-Fluid	▶ Rocktype 1
/ Initial Conditions	Rocktype 2
	Rocktype 3
Numerical	Rocktype 4
✓ Wells & Recurrent	Rocktype 5 Rocktype 6
□	Scale Denosit Tables (SCI DPS)
MODEL: GASWATER	Scale Damage Tables (SCI DM)
□ ✓ PVT Region: 1	Scale Damage Tables (SCEDM
Reservoir temperature (TRES)	
VTG Table	
/ Gas phase density (DENSITY GAS)	

A.			В.			C.			D.							
												SW	KRW	KRG		
SW	KRW	KRG	SW	KRW	KRG							0.01	0 0000	0.9803		
0.25	0.0000	0.40	0.12	0.0000	0.69							0.05	0.0000	0.0221		
0.30	0.0000	0.31	0.15	0.0000	0.65							0.05	0.0000	0.9551		
0.35	0.0000	0.23	0.20	0.0000	0.54	SW	KRW	KRG	SW	KBW	KRG	0.10	0.0000	0.8632	E	
0.40	0.0000	0.16	0.25	0.0000	0.44	0.06	0.0000	0.97	0.01	0.0000	0.0902	0.15	0.0000	0.7913	✓ Components	•
0.45	0.0002	0.10	0.30	0.0001	0.35	0.10	0.0000	0.88	0.01	0.0000	0.0000	0.20	0 0000	0 7182		1.1
0.50	0.0006	0.06	0.35	0.0004	0.27	0.15	0.0000	0.76	0.00	0.0000	0.8632	0.05	0.0000	0.6440	Rock-Fluid	
0.55	0.0013	0.02	0.40	0.0010	0.19	0.20	0.0000	0.65	0.15	0.0000	0.7913	0.25	0.0000	0.6449	/ Initial Conditions	
0.60	0.0024	0.00	0.45	0.0020	0.13	0.25	0.0003	0.54	0.20	0.0000	0.7182	0.30	0.0000	0.5723		
0.65	0.0042	0.00	0.50	0.0036	0.06	0.30	0.0009	0.44	0.25	0.0000	0.6449	0.35	0.0000	0.5012	V Numerical	•
0.70	0.0068	0.00	0.55	0.0000	0.05	0.00	0.0013	0.35	0.30	0.0000	0.5723	0.40	0.0002	0.4323		
0.75	0.0103	0.00	0.60	0.0095	0.02	0.45	0.0065	0.19	0.35	0.0000	0.5012	0.45	0.0006	0.2666	Vells & Recurrent	•
0.80	0.0152	0.00	0.00	0.0140	0.00	0.50	0.0106	0.13	0.40	0.0002	0.4323	0.45	0.0000	0.3000	C Bask Fluid Ontions	
0.00	0.0215	0.00	0.75	0.0283	0.00	0.55	0.0165	0.08	0.45	0.0005	0.3666	0.50	0.0015	0.3045	KOCK Fluid Options	
0.95	0.0200	0.00	0.80	0.0386	0.00	0.60	0.0244	0.04	0.50	0.0013	0.3045	0.55	0.0034	0.2470	Rock Fluid Types	
1.00	0.0526	0.00	0.85	0.0515	0.00	0.65	0.0350	0.02	0.55	0.0029	0.2470	0.60	0.0072	0.1944	⊕ V Rocktype 1	
11		100000	0.90	0.0673	0.00	0.70	0.0486	0.00	0.60	0.0061	0.1944	0.65	0.0140	0 1475	Here & Rocktype 2	
			0.95	0.0866	0.00	0.75	0.0658	0.00	0.65	0.0119	0.1475	0.00	0.0140	0.1475	D . / Pasitama 2	
	Rock Type	l)	1.00	0.1096	0.00	0.80	0.0873	0.00	0.70	0.0220	0.1066	0.70	0.0258	0.1066	H- Kocktype 5	
	V = 0.0001					0.85	0.1136	0.00	0.75	0.0390	0.0721	0.75	0.0459	0.0721	⊞ KRocktype 4	
	K <u>< 0.0001</u>	na				0.90	0.1455	0.00	0.85	0.0007	0.0235	0.80	0.0784	0.0444	E ✔ Rocktype 5	
						0.95	0.1836	0.00	0.00	0.1774	0.0255	0.85	0 1297	0.0235	Rocktype 6	
						1.00	0.2200	0.00	0.95	0.2780	0.0019	0.00	0.2095	0.0005	Segurater Scale Buildun	
			R	ock Type 2)					1.00	0.4255	0.0000	0.90	0.2005	0.0035		
			0	0001 < K <	0.001 md	Ro	ock Type 3)					0.95	0.3266	0.0019		
			0.	0001 - K -	0.001 ma							1.00	0.4999	0.0000		
						0.0	001 < K < 0	.01 md	H	Rock Type	:4)					
									C	0.01 < K <	0.1 md	Rock	Type 5)			
												ROCK	(JPC 5)			
												K > 0.	1 md			

Table 4: Relative-permeability tables for respective rock-types used in single- and multi-section simulation studies.

Data Given





									Prop producer 2:	rsadded_layer11.p	Grid Top	(ft) 1997	-10-01	l laye	er: 22	
GBet		1970-06-01	•	PRC	DUCER				ſ	General Prope	erty Specification					
	Perforations	Rel.	erm.Opti	ons						Edit Specification	n					
			Add	perfs with the	mouse						Only for Start Time, Go to	Pressure		• [l	Jse Regions / Sectors	
由	Use trajector	y perf intervals		Begin	□* _* 人 #	-					Net Pay	PVT Type		Pressure		Grid Bottom
.s. 中				<u> </u>						UNITS:	ft		~		psi	_
Block Address	Connect to	Form factor FF	Status	Ref.Layer	WI (md*ft)	Length (ft)	Block Top (ft)	Block Bottom (ft)		HAS VALUES:			x	_	x	-
6	Surface	₹ 6	Open	۰.	1556.198	46.357	-489.325	-442.968		Whole Grid		1		420		
8	1	₹ 6	Open	\ O	149.214	35.472	-430.693	-395.221		Layer 1						
11	2	6	Open	10	193 575	29 102	-337 961	-308 859		Layer 2						
15	3	6	Open	10	9.025	11 094	-232 939	-221 845		Layer 4						
7	4	16	Open	10	885 198	11 799	-212 059	-200.26		Layer 5						
0	5	16	Open	10	2 422	12 206	-212.000	.197.055		Layer 6						
10	0		Open	10	2.423	13.200	-200.20	-107.000		Layer /						
19	6	6	Open	.0	2.616	5.115	-187.055	-181.94		Layer 9						
-	7	6	Open	0	32.557	7.062	-171.328	-164.266		I suar 10						
2 21	-															

The ff-factor = 1 represents unfeatured well and ff>1 represents a well had been hydraulic fractured. the initial reservoir pressure is 460 and can vary between 400-500psi.





Initial State

History Matched

CGBet



Initial State

History Matched











#	User Block Address	Connect to	Form factor FF	Status	Ref.Layer	WI (md*ft)	L
1	22 22 13	Surface	6	Open <	•	1.936	4
2	22 22 14	1	6	Open	0	1.585	1
3	22 22 15	2	6	Open	0	9.025	1
4	22 22 16	3	6	Open	0	0.328	9
5	22 22 17	4	6	Open	0	885.198	1
6	22 22 18	5	6	Open	0	2.423	1
7	22 22 19	6	6	Open	0	2.616	5
8	22 22 20	7	6	Open	0	0.367	1
9	22 22 21	8	6	Open	0	32.557	7
10	22 22 22	9	6	Open	0	0.077	1
* 11	22 22 23	10	6	Open <	0	387.731	3

After

....

1.1

PRODUCER Well & Date: • CGBet 1970-06-01 Perforations Rel.Perm.Options General Add perfs with the mouse ** .* ★ ⊞ Begin 串 Use trajectory perf intervals... Perforated grid blocks: • # User Block Address Connect to Form factor FF Status Ref.Layer WI (md*ft) 1 22 22 6 ₹ 6 ۰ ا 1556.198 Surface Open 2 22 22 8 ₹ 6 10 149.214 1 Open × 3 22 22 11 2 ₹ 6 10 193.575 Open 4 22 22 15 3 ₹ 6 Open 10 9.025 ₹ 6 10 5 22 22 17 4 Open 885.198 ₹ 6 22 22 18 5 10 2.423 6 Open ₹ 6 10 7 22 22 19 6 Open 2.616 7 ₹ 6 10 22 22 21 Open 32.557 8 ₹ 6 10 * 9 22 22 23 8 Open 387.731 Reset Well OK Cancel Apply Help Before



Decrease in Pressure





PPer

CGPer

IPer

Boundary Well PPer





332

232

132

32

-68

-168-

1975

1980

1970

Well Bottom-hole Pressure (psi)



CGBet Case1_Pres_CGBet_volume_multi.irf

Higher ff, better results?



Error



PZim CGZim

CGScho

CGRIPer

111

4

Simulation Dates			Well Events		
- no keyword data exists on this date (it can be a constructed by the constructed by	e deleted)		displayed wells 29 of 29	2016-06-01	• Well: 'CGBet' at 2016-06-01 (28855.00 day)
# Date & Time (day) set STO	P Comments	Add a new date:	Name / Date Event ^	ID & Type	Constraint definition previous date: 1970-06-01
913 2015-10-01 (28611.00)		Add a range of dates:	2015-03-01 ALTER 2015-09-01 ALTER 2015-09-01 ALTER 2015-10-01 ALTER 2015-11-01 ALTER 2015-12-01 ALTER	Constraints Multipliers Wellbore	# Constraint Parameter Limit/Mode Value Action * 1 OPERATE STG surface gas rate MAX 171066.6719 ft CONT 2 OPERATE BHP bottom hole pressure MIN 28 psi CONT select new
917 2016-02-01 (28734.00) 918 2016-03-01 (28763.00) 919 2016-04-01 (28794.00) 920 2016-05-01 (28824.00) 921 2016-06-01 (28855.00)		Delete all empty dates:	2016-01-01 ALTER 2016-02-01 ALTER 2016-03-01 ALTER 2016-04-01 ALTER 2016-05-01 ALTER 2016-05-01 ALTER 2016-07-01 ALTER	Injected Fluid Workover Options Layer Gradient	Max. number of continue-repeat allowed (MXCNRPT)
322 2016-07-01 (28385.00) 923 2016-08-01 (28916.00) 924 2016-09-01 (28947.00) 925 2016-10-01 (28977.00) 926 2016-11-01 (2908.00) 927 2016-12-01 (29038.00)		To limit output file size, limit grid output (with WSRF) to: Do not limit grid output Remove existing keywords (WSRF) to limit grid output	2016-08-01 ALTER 2016-09-01 ALTER 2016-10-01 ALTER 2016-11-01 ALTER 2016-12-01 ALTER 2017-01-01 ALTER 2017-01-01 ALTER	Gas Lift Guide Rates Fracture Proxy Comments	< constraint modifiers > Change current primary constraint (ALTER) Set new or change old constraint (TARGET) STG 51763.19922 ft3/day # Parameter Value select new select new
928 2017-01-01 (29069.00) □ 929 2017-02-01 (29100.00) ✔ <	, ·	Recommendations Close	CGFuk 1970-05-01 WELL PRODUCER ↓ Sort by: ◎ Name Tools ▶	H	Ater: previous date: 2016-05-01 Target: previous date: <none> Reset Page Auto-apply QK Cancel Apply Help</none>
1365 * 2050-04-01 (41212.00) 1366 * 2050-05-01 (41242.00) 1367 2050-06-01 (41273.00)					











From CMG result 3D



Perforated to layer 9



Perforated to layer 9





Perforated to layer 11



Perforated to layer 11



















Conclusion





Perforated to layer 11

Total Production Increased: 0.01827 e+11 ft^3 Total percent of Production Increased: 1.3009%

Thank You for Watching



Especially thanks for Dr. Esmail Ansari for instructing the course during the summer.

Wish you all have a good rest of your Summer.