

Simulation-based Grid Size, Pseudocomponent and Injection Method Selection to Optimize EOR CO2 Injection: Pertamina Field Case Study

Name : Danang Yudo

Title : Reservoir & Production Specialist

Company : PT. PERTAMINA (PERSERO)



What's Next?

SIS Global Forum 2017

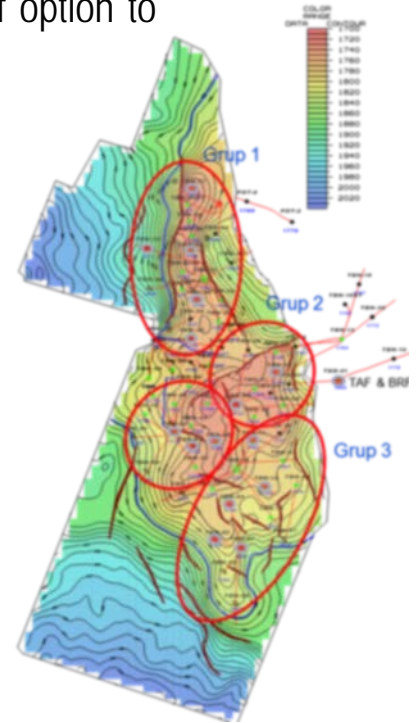
September 13-15

Le Palais des Congrès de Paris

Schlumberger

BACKGROUNDS

- ❖ Heterogeneous carbonate reservoir with depleted pressure.
- ❖ Low recovery factor, CO₂ injection as one of method to be studied as one of option to improve the recovery factor.
- ❖ CO₂ injection study was conducted using Compositional simulator.
- ❖ High heterogeneity of PVT data gave a big challenge when creating EOS.
- ❖ Sector model was needed to observe the effect of CO₂ injection to a pattern.



CHALLENGES

- ❖ Limited Pre-Feasibility Studies time
- ❖ Long simulator running time
- ❖ Limited parallel license

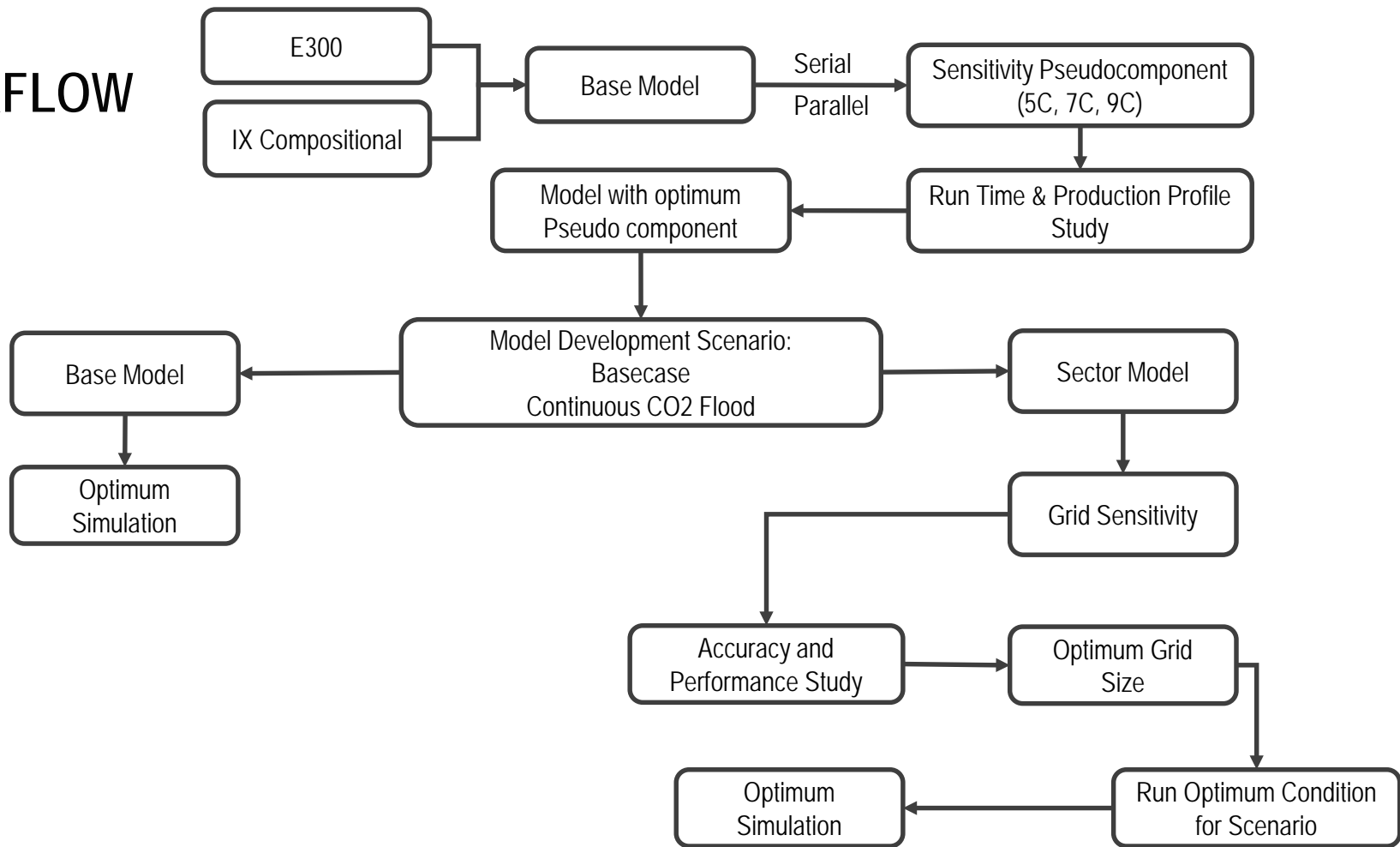
OBJECTIVES

- ❖ Observe the effect of the numbers of components in the dynamic model
- ❖ Optimize the use of grid size so as to produce good accuracy in terms of production performance and run time in the reservoir simulation

DYNAMIC MODEL OVERVIEW

- Carbonate reservoir with permeability 0.1mD – 300mD, porosity: 0.02 – 0.4
- Current number of wells: 64 (active 47 producer and 11 Injector)
- Number of grid: 96 x 192 x 45 (50m x 50m)
- Eclipse with 7 parallel license
- Workstation with Intel[®] Xeon[®] CPU E5-2637W 0 @ 3.50GHZ (8 CPUs), 24 GB RAM

WORKFLOW



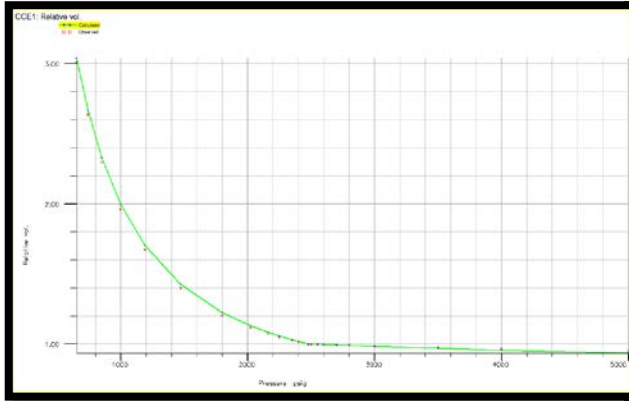
PRESSURE (PSIG)	RELATIVE VOLUME
5000	0.948
4000	0.9643
3500	0.9731
3000	0.9844
2800	0.9908
2700	0.9934
2600	0.9963
2550	0.9979
2500	0.9994
2480	1
2400	1.0158
2350	1.0265
2250	1.0499
2160	1.0737
2020	1.1166
1800	1.2028
1470	1.3975
1190	1.6711
1000	1.9614
850	2.2955
740	2.6356
650	3.006
CCE	

PRESSURE (PSIG)	OIL.REL.VOLUME (RB/STB)	GAS-OIL RATIO (MSCF/STB)	GAS DEV FACTOR Z	RES.OIL DENSITY (LB/CUFT)	GAS.REL.DENSITY	GAS.VOL.FACTOR (RB/MSCF)	LIQ.VIS CP	VAP.VIS CP
2480	1.7792	1.276		40.1724			0.3046	
2000	1.6339	1.013	0.7823	41.6395	0.9603	1.3875	0.3071	0.01879
1500	1.5088	0.785	0.8091	43.1752	0.9312	1.909	0.3389	0.01631
1000	1.3815	0.569	0.8462	45.1105	0.9606	2.9805	0.4125	0.01435
500	1.2602	0.362	0.9042	46.8647	1.1564	6.2785	0.5514	0.012
0	1.0921	0		47.6201	1.4333		0.8653	
DIFFERENTIAL LIBERATION								

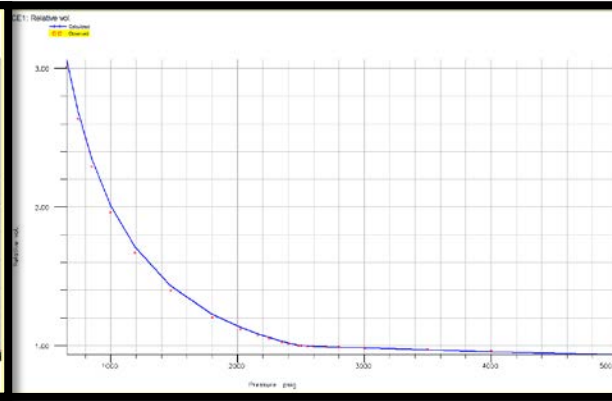
Components	ZI (Percent)	Weight Fraction (Percent)	Mol Weight (kg-mole)
	CO2	1.49	
C1	39.59		
C2	8.72		
C3	9.82		
IC4	2.29		
NC4	3.02		
IC5	1.18		
NC5	1.11		
C6	1.42		
C7+	31.36	209.9	0.8434
COMPOSITION			

EXPERIMENT DATA

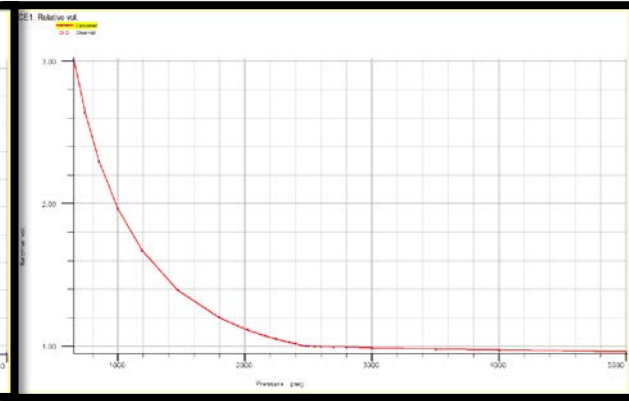
PVTi REGRESSION RESULT



5 Components



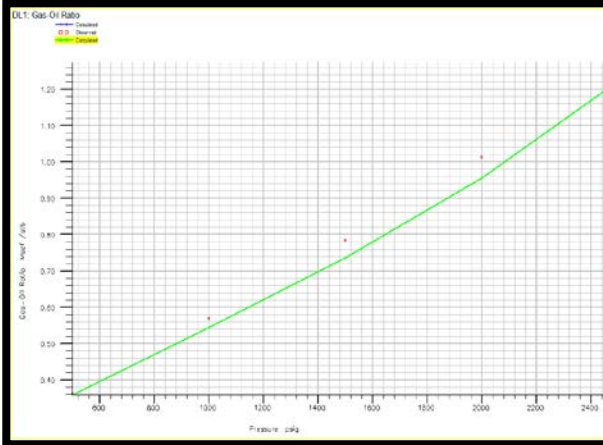
7 Components



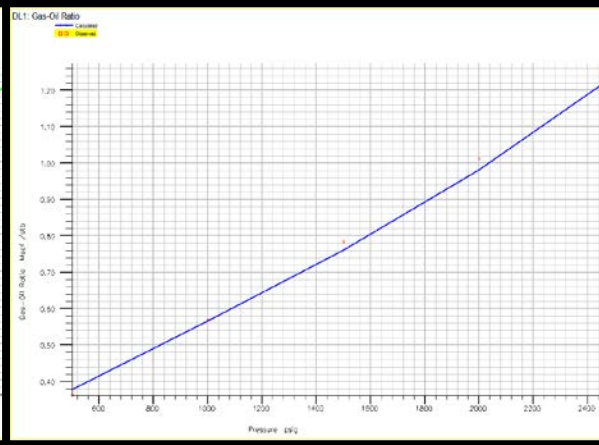
9 Components

RELATIVE VOL - CCE

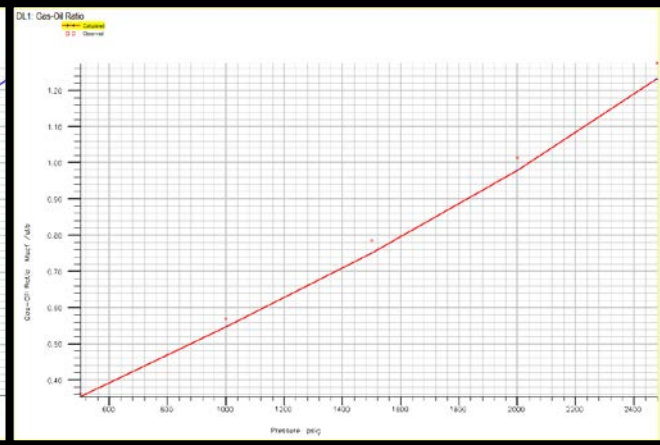
PVTi REGRESSION RESULT



5 Components



7 Components

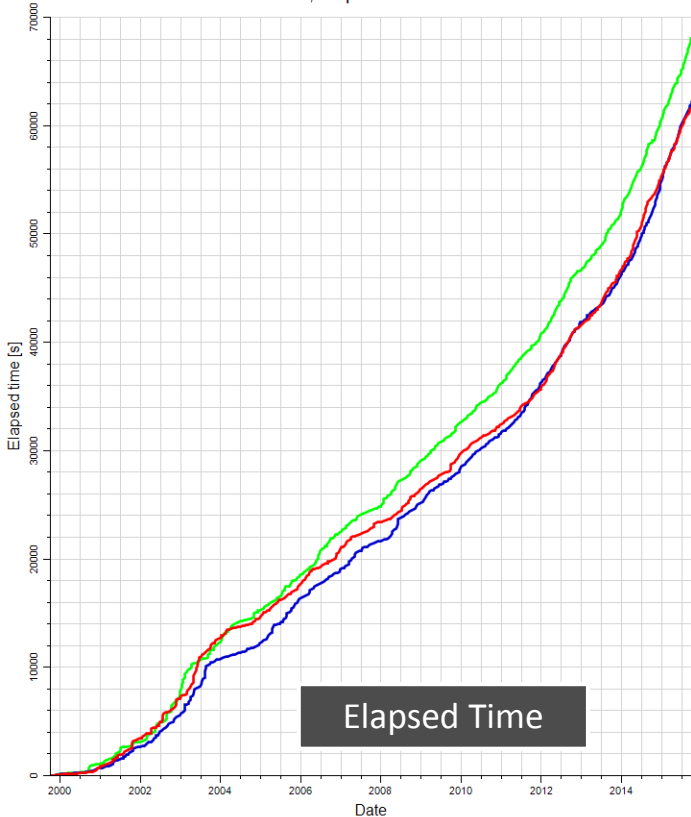


9 Components

GOR - DL

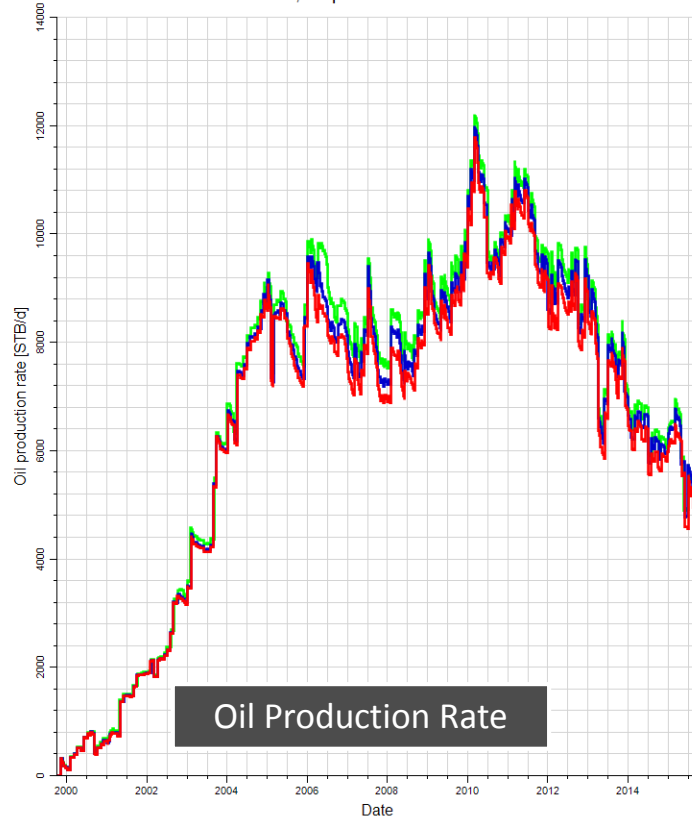
HISTORY MATCHING PHASE

Field, Elapsed time



Elapsed Time

Field, Oil production rate



Oil Production Rate

— RS_5C-REV_CO_E300 — RS_7C-REV_CO_E300 — RS_9C-REV_CO_E300

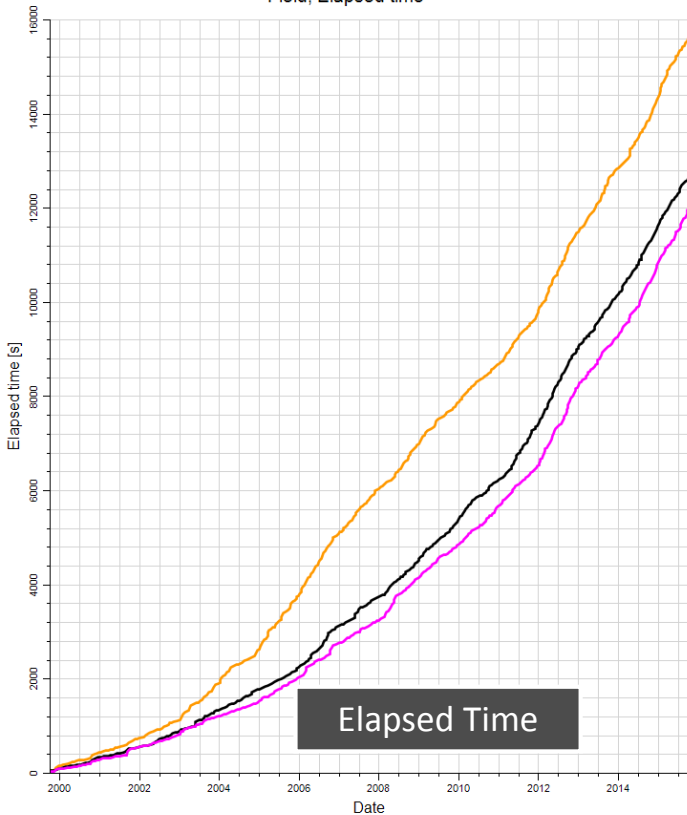
- █ : 5 Components
- █ : 7 Components
- █ : 9 Components

No	Cases	Time Elapsed (Second)	Time Elapsed (Hours)
1	Serial, 5 Components, E300	61765.82	17.16
2	Serial, 7 Components, E300	62335.50	17.32
3	Serial, 9 Components, E300	68202.35	18.95

No	Cases	Oil Rate Production Average Error (%)	Mark
1	Serial, 5 Components, E300	0.00	Base Line
2	Serial, 7 Components, E300	2.19	
3	Serial, 9 Components, E300	5.05	

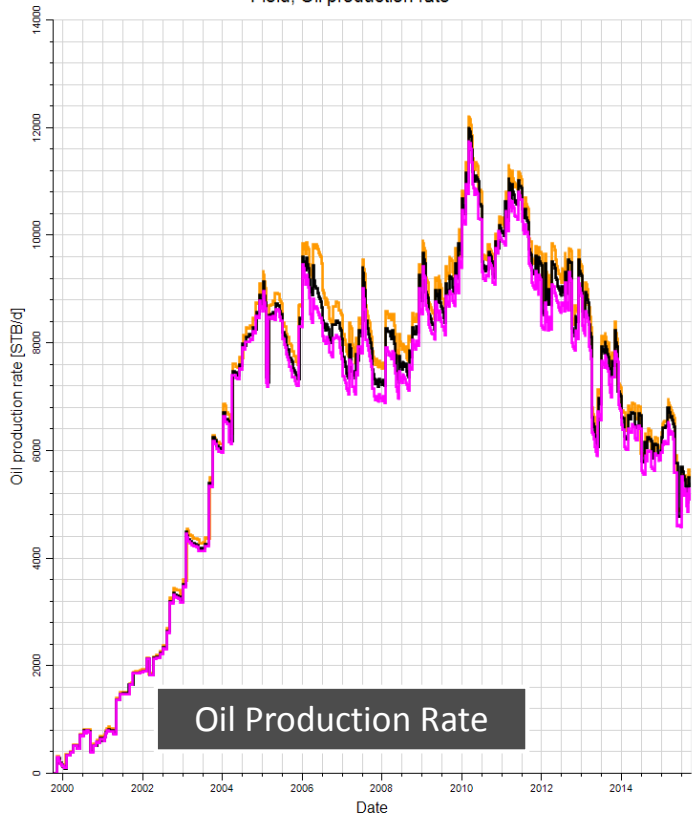
Case : Serial Run, Components Sensitivity, E300

Field, Elapsed time



Elapsed Time

Field, Oil production rate



Oil Production Rate

RS_5C-REV_CO_PAR7_E300 RS_7C-REV_CO_PAR7_E300 RS_9C-REV_CO_PAR7_E300

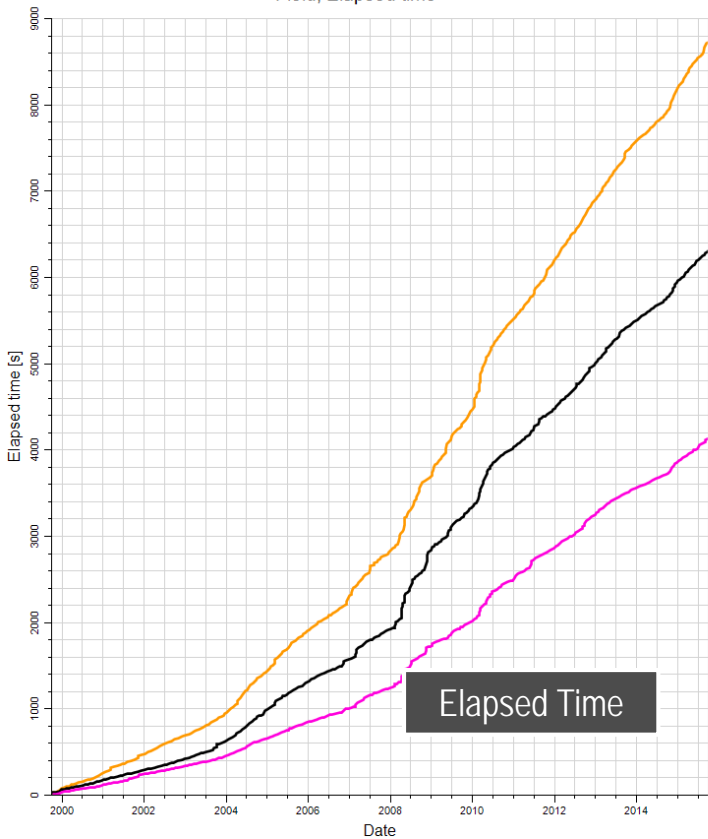
█ : 5 Components
█ : 7 Components
█ : 9 Components

No	Cases	Time Elapsed (Second)	Time Elapsed (Hours)
1	Par 7, 5 Components, E300	12001.50	3.33
2	Par 7, 7 Components, E300	12659.50	3.52
3	Par 7, 9 Components, E300	15640.80	4.34

No	Cases	Oil Rate Production Average Error (%)	Mark
1	Par 7, 5 Components, E300	0.00	Base Line
2	Par 7, 7 Components, E300	2.44	
3	Par 7, 9 Components, E300	5.03	

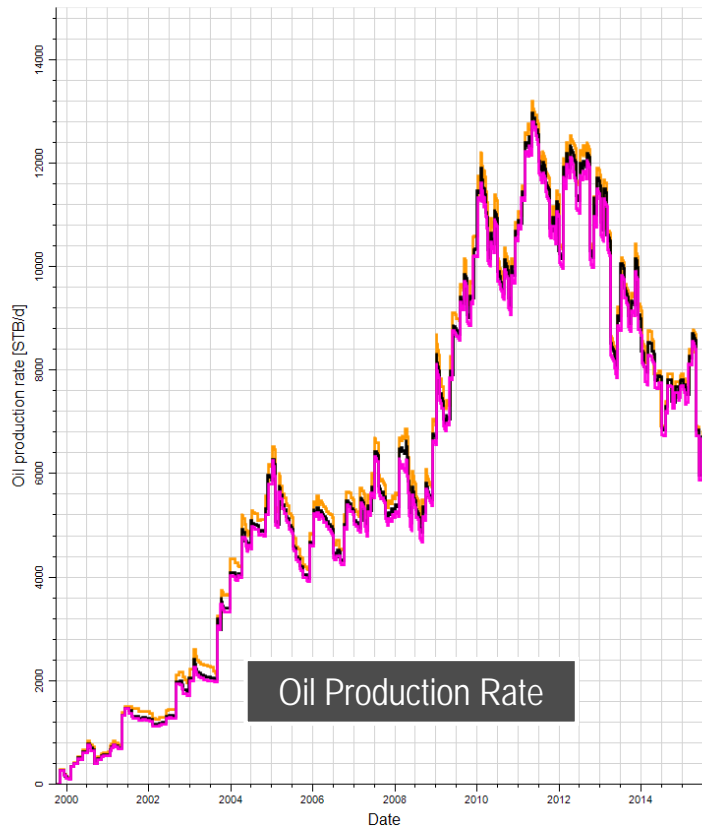
Case : Parallel Run (7 Cores), Components Sensitivity, E300

Field, Elapsed time



RS_5C-REV_CO_PAR7_IX RS_7C-REV_CO_PAR7_IX RS_9C-REV_CO_PAR7_IX

Field, Oil production rate



■ : 5 Components

■ : 7 Components

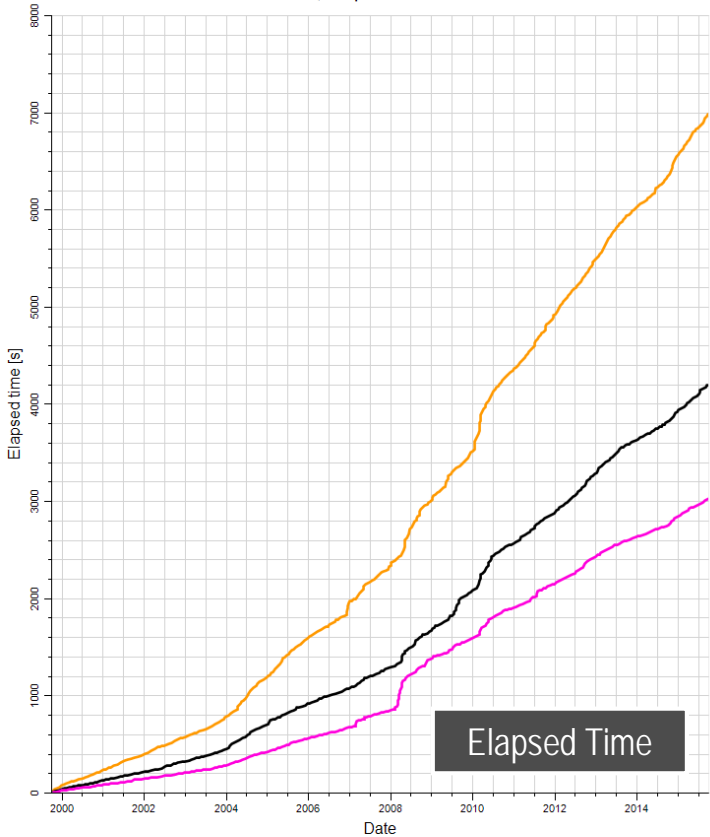
■ : 9 Components

No	Cases	Time Elapsed (Second)	Time Elapsed (Hours)
1	Par 7, 5 Components, IX	4149.00	1.15
2	Par 7, 7 Components, IX	6331.00	1.76
3	Par 7, 9 Components, IX	8794.00	2.44

No	Cases	Oil Rate Production Average Error (%)	Mark
1	Par 7, 5 Components, IX	0.00	Base Line
2	Par 7, 7 Components, IX	2.09	
3	Par 7, 9 Components, IX	6.15	

Case : Parallel Run (7 Cores), Components Sensitivity, IX

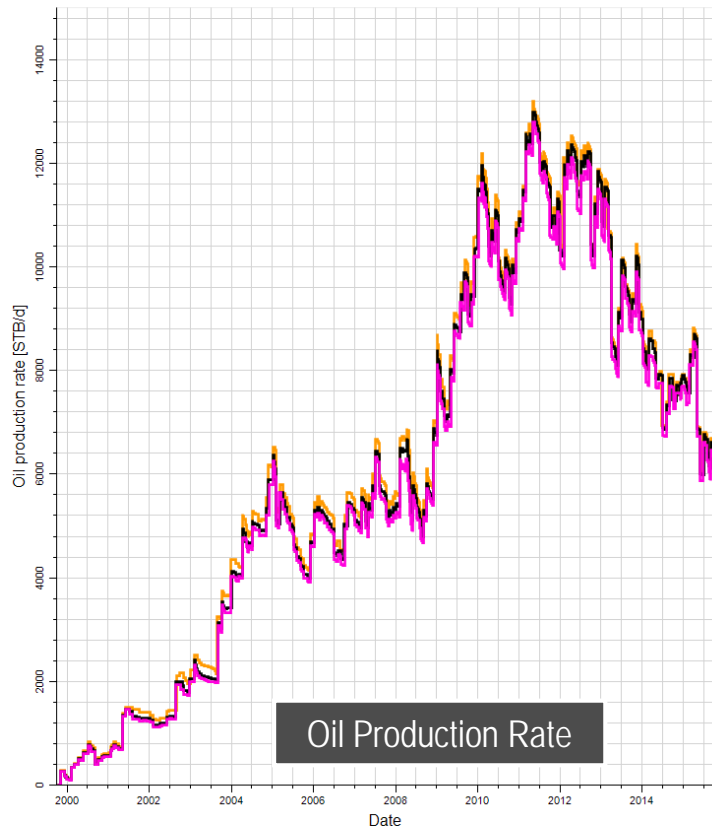
Field, Elapsed time



Elapsed Time

RS_5C-REV_CO_PAR16_IX RS_7C-REV_CO_PAR16_IX RS_9C-REV_CO_PAR16_IX

Field, Oil production rate



Oil Production Rate

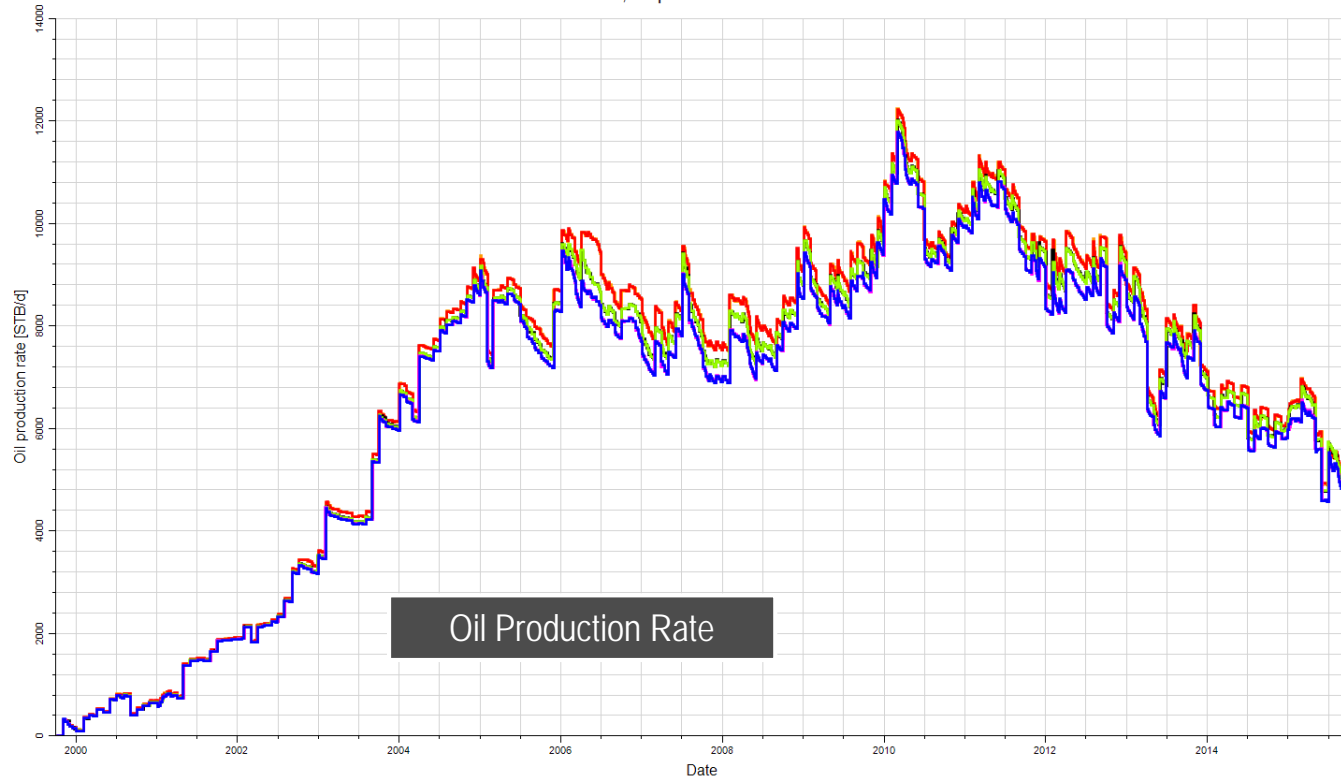
█ : 5 Components
█ : 7 Components
█ : 9 Components

No	Cases	Time Elapsed (Second)	Time Elapsed (Hours)
1	Par 16, 5 Components, IX	3044.00	0.85
2	Par 16, 7 Components, IX	4221.00	1.17
3	Par 16, 9 Components, IX	7002.00	1.95

No	Cases	Oil Rate Production Average Error (%)	Mark
1	Par 16, 5 Components, IX	0.00	Base Line
2	Par 16, 7 Components, IX	2.28	
3	Par 16, 9 Components, IX	6.09	

Case : Parallel Run (16 Cores), Components Sensitivity, IX

Field, Oil production rate



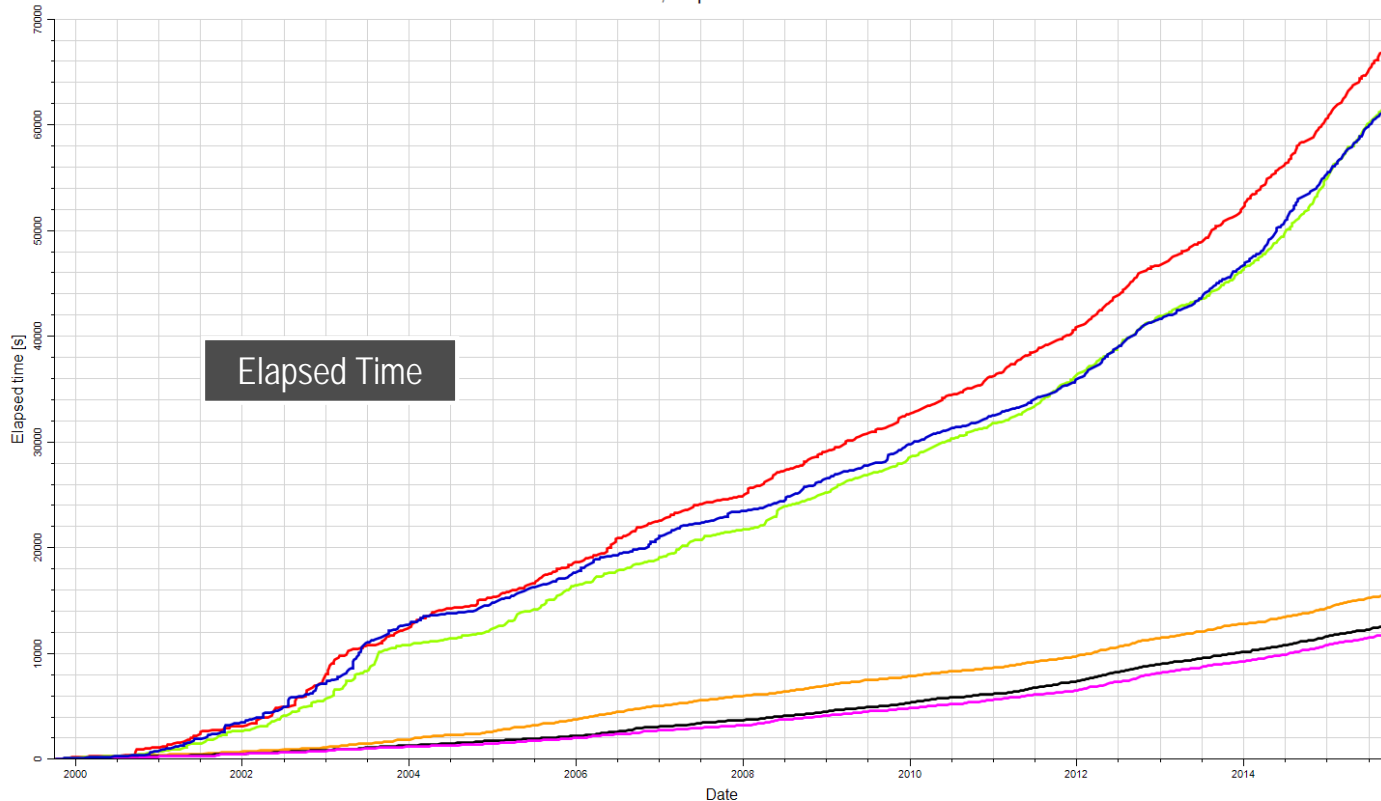
— RS_5C-REV_CO_E300
 — RS_5C-REV_CO_PAR7_E300
 — RS_7C-REV_CO_E300
 — RS_7C-REV_CO_PAR7_E300
— RS_9C-REV_CO_E300
 — RS_9C-REV_CO_PAR7_E300

- █ : Serial – 5 Components
- █ : Serial - 7 Components
- █ : Serial - 9 Components
- █ : Par 7 – 5 Components
- █ : Par 7 - 7 Components
- █ : Par 7 - 9 Components

No	Cases	Serial	Parallel 7
		Oil Rate Production Average Error (%)	
1	5 Components, E300	0.00	0.00
2	7 Components, E300	2.19	2.44
3	9 Components, E300	5.05	5.03

Oil Production Rate Comparison Between Serial and parallel 7 Case E300

Field, Elapsed time



Elapsed Time

- █ : Serial – 5 Components
- █ : Serial - 7 Components
- █ : Serial - 9 Components
- █ : Par 7 – 5 Components
- █ : Par 7 - 7 Components
- █ : Par 7 - 9 Components

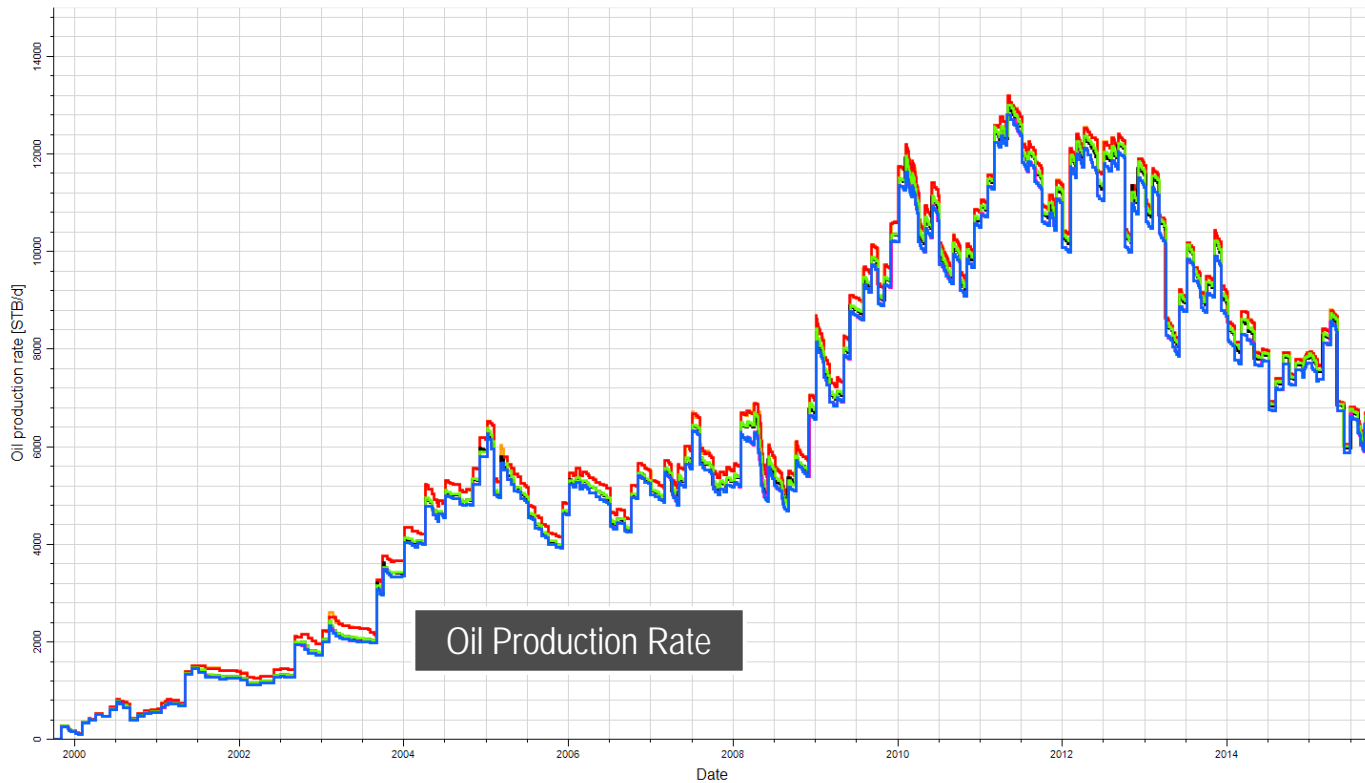
No	Cases	Serial	Parallel 7	Times Reduction
		Time Elapsed (Hours)		
1	5 Components, E300	17.16	3.33	5.15
2	7 Components, E300	17.32	3.52	4.92
3	9 Components, E300	18.95	4.34	4.36

— RS_5C-REV_CO_E300
 — RS_5C-REV_CO_PAR7_E300
 — RS_7C-REV_CO_E300
 — RS_7C-REV_CO_PAR7_E300
— RS_9C-REV_CO_E300
 — RS_9C-REV_CO_PAR7_E300

Elapsed Time Comparison Between Serial and parallel 7 Case (E300)

Field, Oil production rate

- █ : Par 16 – 5 Components
- █ : Par 16 - 7 Components
- █ : Par 16 - 9 Components
- █ : Par 7 – 5 Components
- █ : Par 7 - 7 Components
- █ : Par 7 - 9 Components



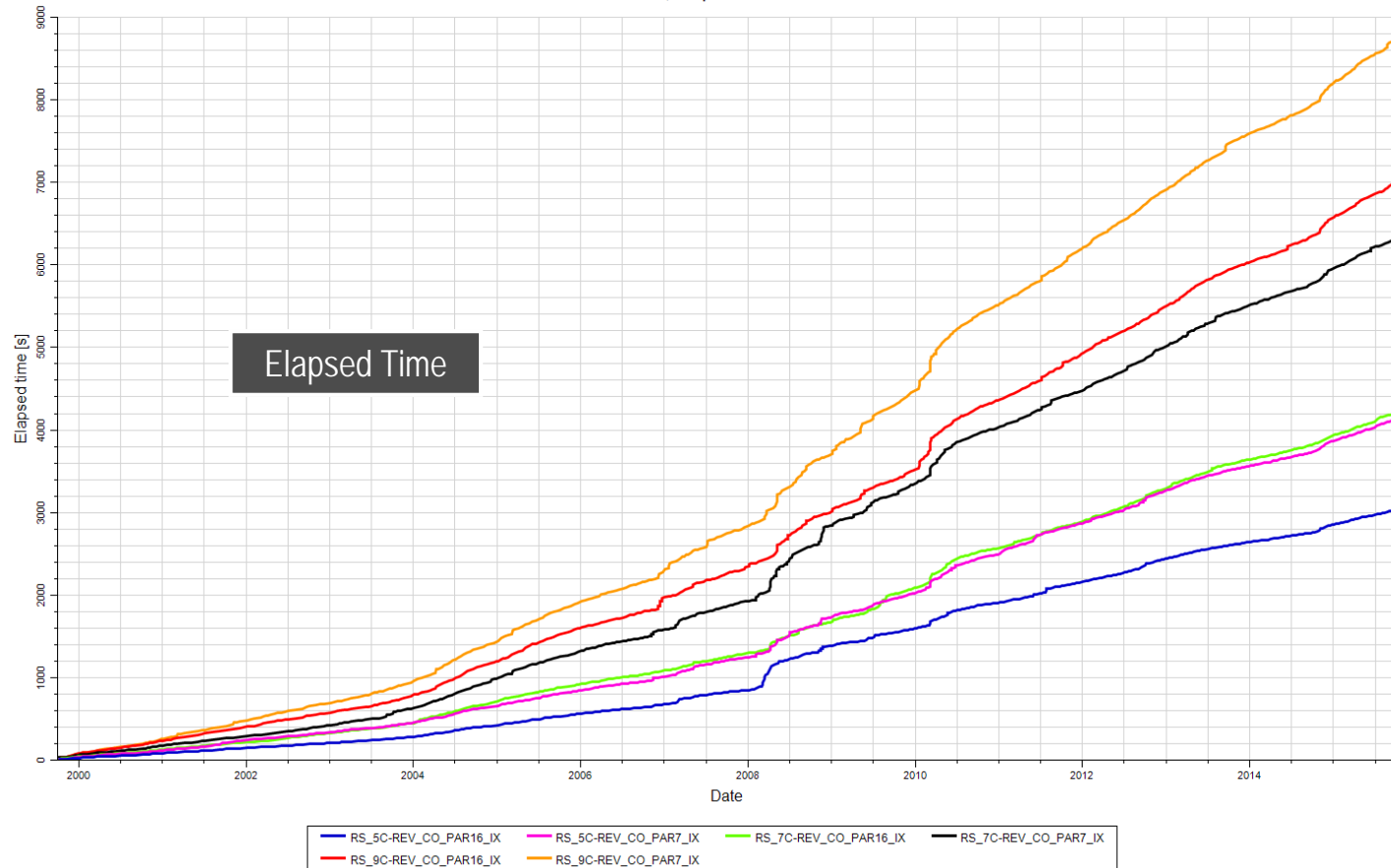
Oil Production Rate

— RS_5C-REV_CO_PAR16_IX — RS_5C-REV_CO_PAR7_IX — RS_7C-REV_CO_PAR16_IX — RS_7C-REV_CO_PART_IX
— RS_9C-REV_CO_PAR16_IX — RS_9C-REV_CO_PAR7_IX

No	Cases	Parallel 7	Parallel 16
		Oil Rate Production Average Error (%)	
1	5 Components, E300	0.00	0.00
2	7 Components, E300	2.44	2.09
3	9 Components, E300	5.03	6.15

Oil Production Rate Comparison Between parallel 7 & 16 Cores Case (IX)

Field, Elapsed time



Elapsed Time

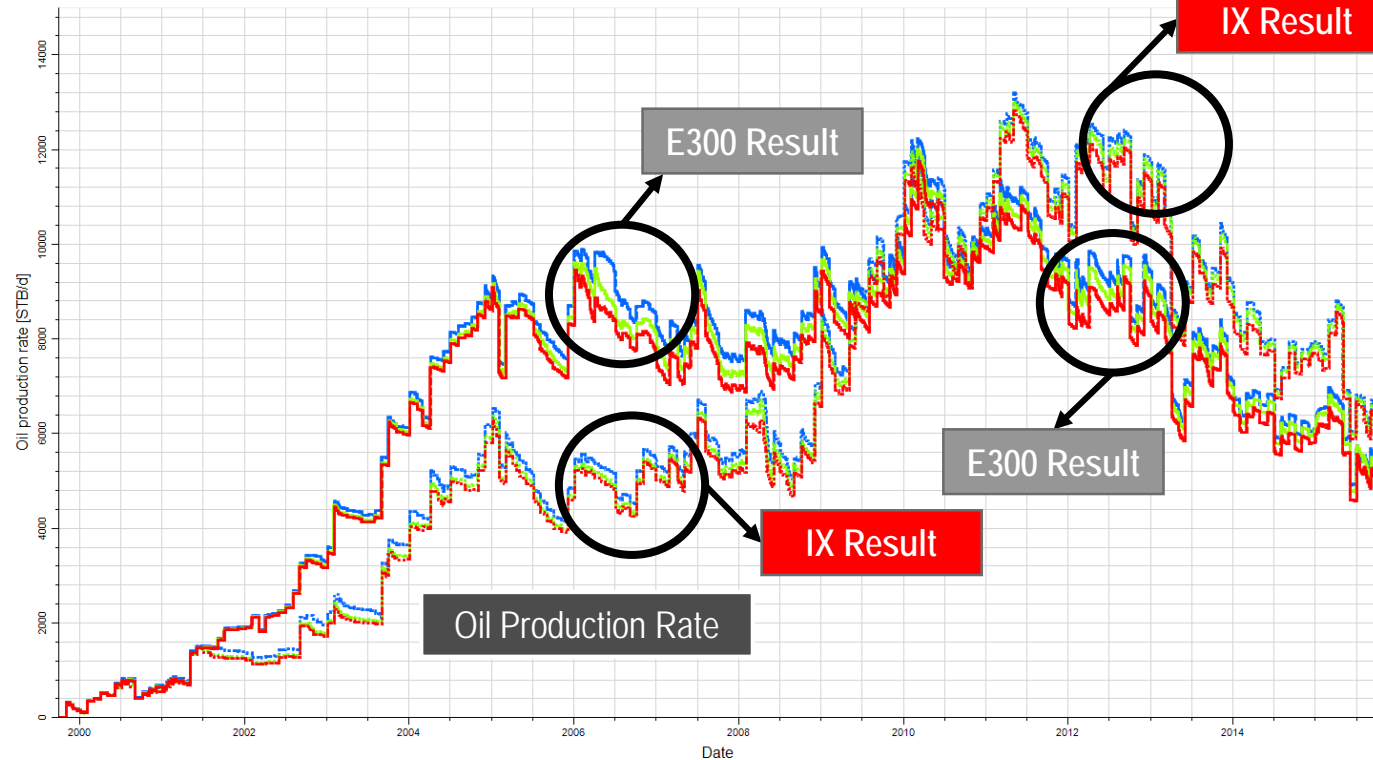
- █ : Par 16 – 5 Components
- █ : Par 16 - 7 Components
- █ : Par 16 - 9 Components
- █ : Par 7 – 5 Components
- █ : Par 7 - 7 Components
- █ : Par 7 - 9 Components

No	Cases	Parallel 7	Parallel 16	Reduction (Times)
		Time Elapsed (Hours)		
1	5 Components, IX	1.15	0.85	1.36
2	7 Components, IX	1.76	1.17	1.50
3	9 Components, IX	2.44	1.95	1.26

— RS_5C-REV_CO_PAR16_IX
 — RS_5C-REV_CO_PAR7_IX
 — RS_7C-REV_CO_PAR16_IX
 — RS_7C-REV_CO_PAR7_IX
— RS_9C-REV_CO_PAR16_IX
 — RS_9C-REV_CO_PAR7_IX

Elapsed Time Comparison Between parallel 7 & 16 Cores Case (IX)

Field, Oil production rate

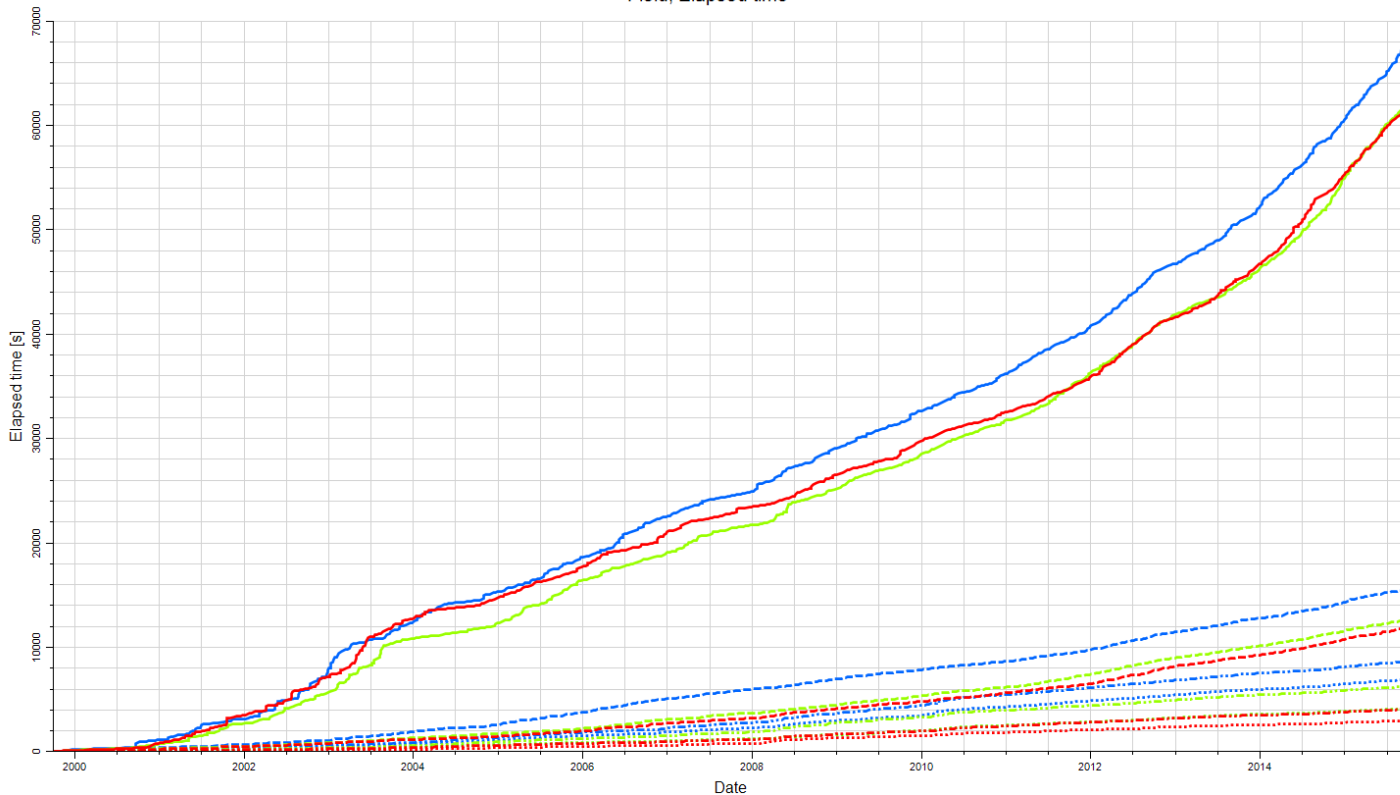


- 5 Components
- 7 Components
- 9 Components

RS_5C-REV_CO_E300	RS_5C-REV_CO_PAR16_IX	RS_5C-REV_CO_PAR7_E300	RS_5C-REV_CO_PAR7_IX
RS_7C-REV_CO_E300	RS_7C-REV_CO_PAR16_IX	RS_7C-REV_CO_PAR7_E300	RS_7C-REV_CO_PAR7_IX
RS_9C-REV_CO_E300	RS_9C-REV_CO_PAR16_IX	RS_9C-REV_CO_PAR7_E300	RS_9C-REV_CO_PAR7_IX

Oil Production Rate Comparison For All Cases

Field, Elapsed time



— RS_5C-REV_CO_E300	⋯ RS_5C-REV_CO_PAR16_IX	- - RS_5C-REV_CO_PAR7_E300	⋯ RS_5C-REV_CO_PAR7_IX
— RS_7C-REV_CO_E300	⋯ RS_7C-REV_CO_PAR16_IX	- - RS_7C-REV_CO_PAR7_E300	⋯ RS_7C-REV_CO_PAR7_IX
— RS_9C-REV_CO_E300	⋯ RS_9C-REV_CO_PAR16_IX	- - RS_9C-REV_CO_PAR7_E300	⋯ RS_9C-REV_CO_PAR7_IX

- 5 Components
- 7 Components
- 9 Components
- Serial - E300
- ⋯ Par16 - IX
- - Par7 - E300
- . Par7 - IX
- Serial - E300
- ⋯ Par16 - IX
- - Par7 - E300
- . Par7 - IX
- Serial - E300
- ⋯ Par16 - IX
- - Par7 - E300
- . Par7 - IX

Elapsed Time Comparison For All Cases

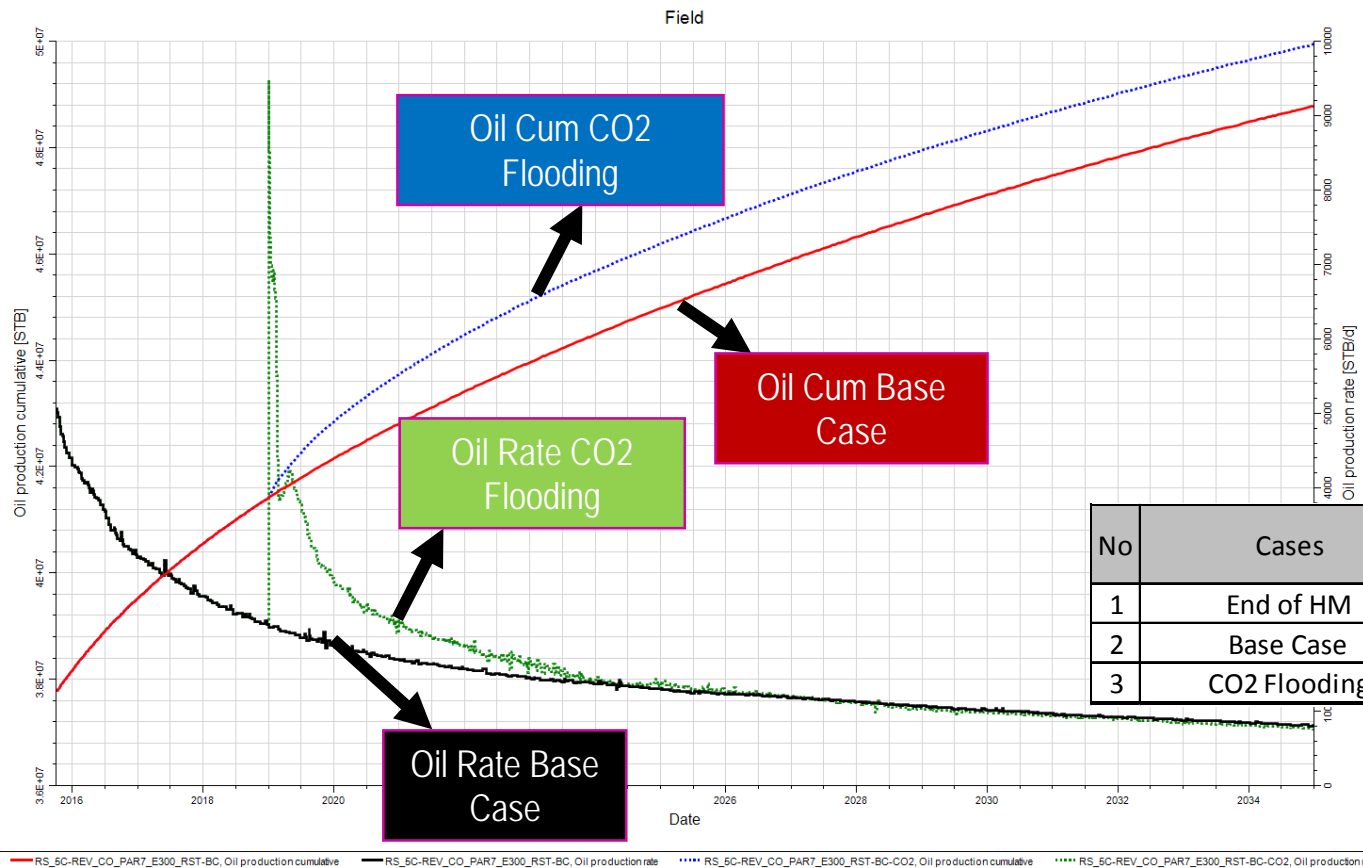
Elapsed Time Summary for All Cases in HM

No	Cases	Serial E300	Parallel 7 E300	Parallel 7 IX	Parallel 16 IX	Serial E300	Parallel 7 E300	Parallel 7 IX	Parallel 16 IX
		Time Elapsed (Hours)				Reduction (Times)			
1	5 Components	17.16	3.33	1.15	0.85	1.00	5.15	14.89	20.29
2	7 Components	17.32	3.52	1.76	1.17	1.00	4.92	9.85	14.77
3	9 Components	18.95	4.34	2.44	1.95	1.00	4.36	7.76	9.74

Oil Rate Production Average Error Summary for All Cases in HM

No	Cases	Serial E300	Parallel 7 E300	Parallel 7 IX	Parallel 16 IX	Mark
		Oil Rate Production Average Error (%)				
1	5 Components	0.00	0.00	0.00	0.00	Base Line Calculation
2	7 Components	2.19	2.44	2.44	2.09	
3	9 Components	5.05	5.03	5.03	6.15	

FORECASTING PHASE



Note :

- Using Base Model For This Case
- Restart Model Used by 5 Components and 7 Parallel Case
- E300

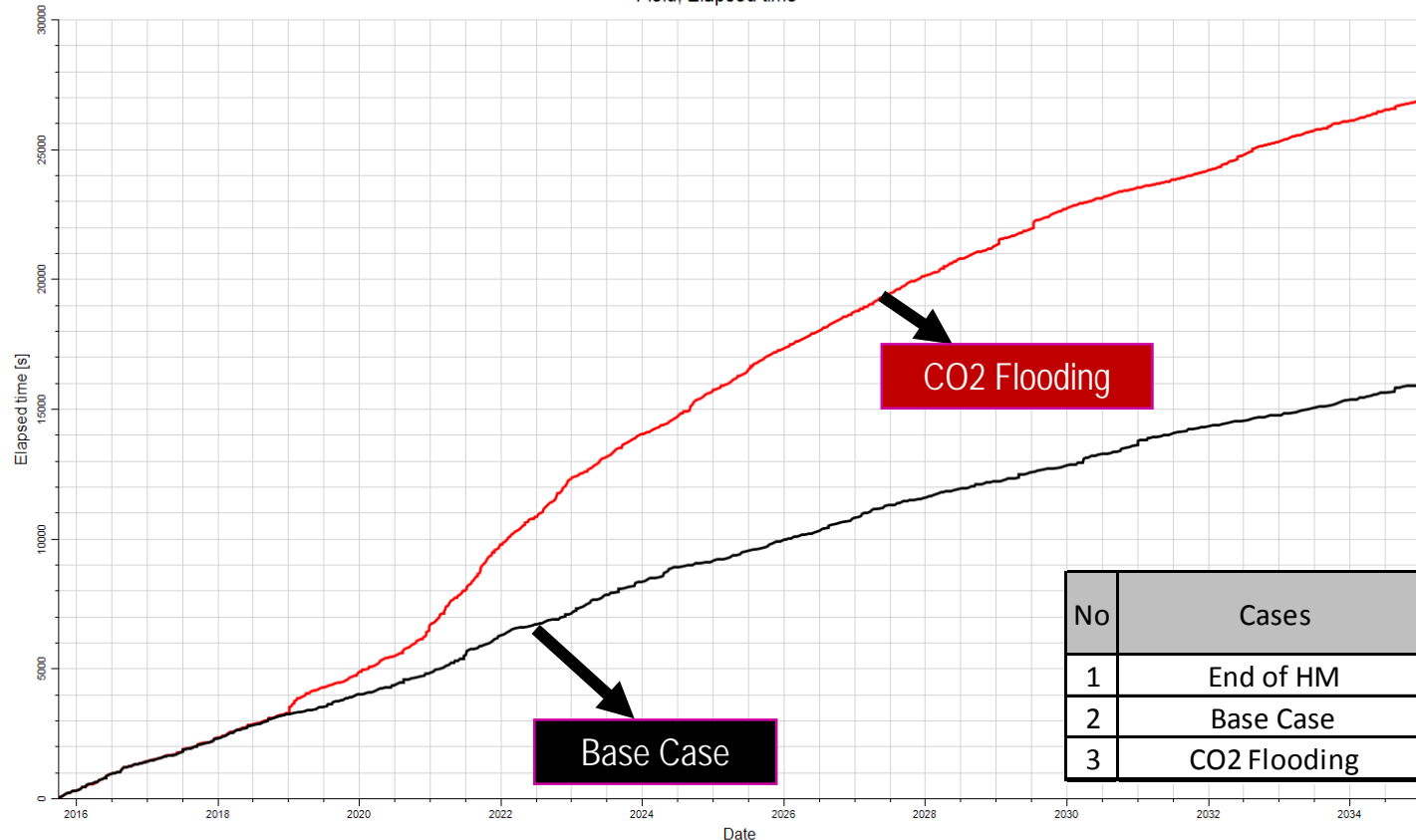
No	Cases	Np (MMSTB)	Gain Np (MMSTB)
1	End of HM	37.75	
2	Base Case	48.78	Base Line
3	CO2 Flooding	49.95	1.17

Oil Production Performance Comparison (Basecase & CO2 Flooding) E300

Field, Elapsed time

Note :

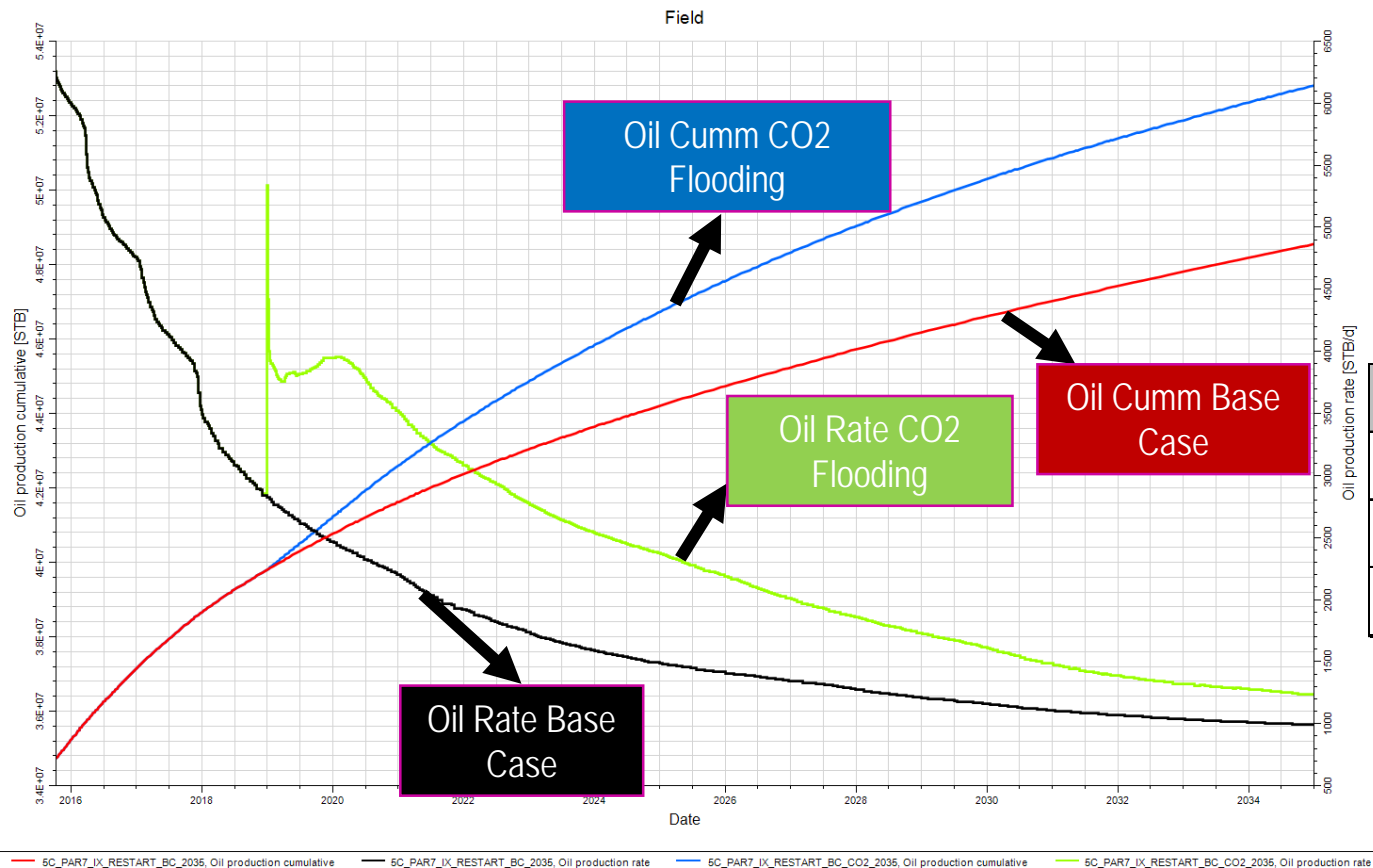
- Using Base Model For This Case
- Restart Model Used by 5 Components and 7 Parallel Case
- E300



No	Cases	Elapsed (Second)	Elapsed (Hours)
1	End of HM	12001.50	3.33
2	Base Case	15991.60	4.44
3	CO2 Flooding	26932.70	7.48

— RS_5C-REV_CO_PAR7_E300_RST-BC — RS_5C-REV_CO_PAR7_E300_RST-BC-CO2

Elapsed Comparison (Basecase & CO2 Flooding) E300



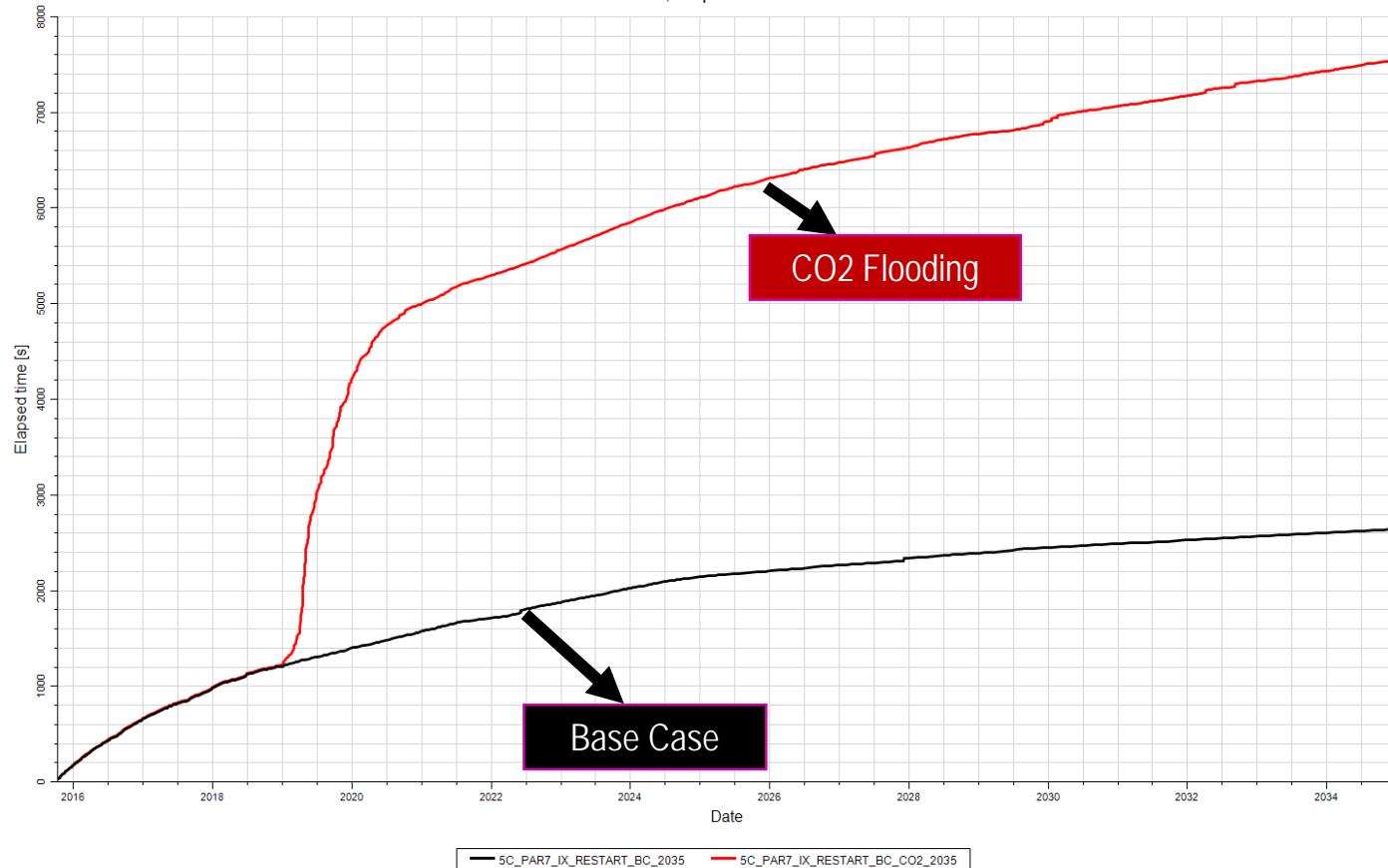
Note :

- Using Base Model For This Case
- Restart Model Used by 5 Components and 7 Parallel Case
- IX

No	Cases	Np (MMSTB)	Gain Np
1	End of HM	34.74	
2	Base Case	48.54	Base Line
3	CO2 Flooding	52.81	4.27

Oil Production Performance Comparison (Basecase & CO2 Flooding) IX

Field, Elapsed time

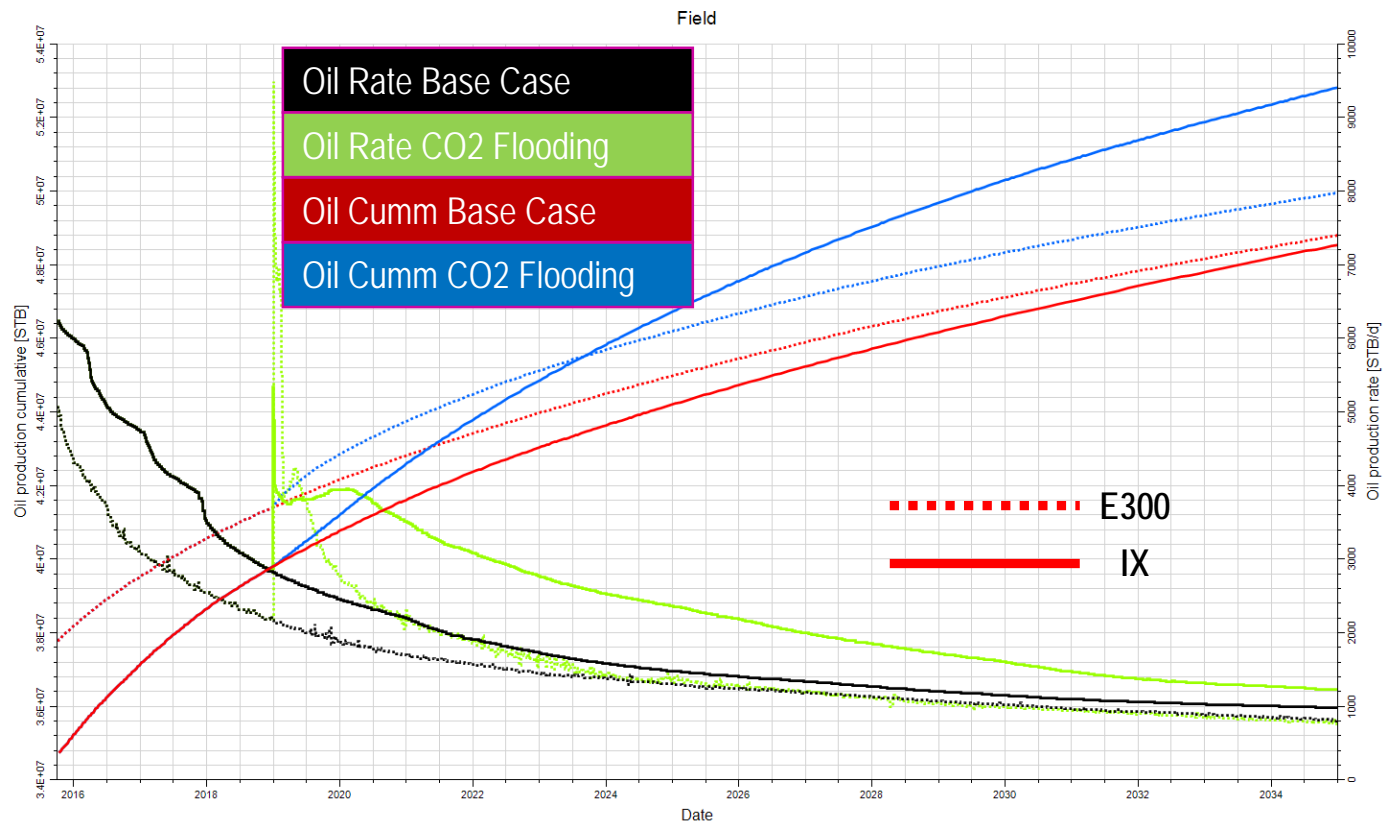


Note :

- Using Base Model For This Case
- Restart Model Used by 5 Components and 7 Parallel Case
- IX

No	Cases	Elapsed (Second)	Elapsed (Hours)
1	End of HM	4149.00	1.15
2	Base Case	2655.00	0.74
3	CO2 Flooding	7554.00	2.10

Elapsed Comparison (Basecase & CO2 Flooding) IX



Note :

- Using Base Model For This Case
- Restart Model Used by 5 Components and 7 Parallel Case
- IX and E300

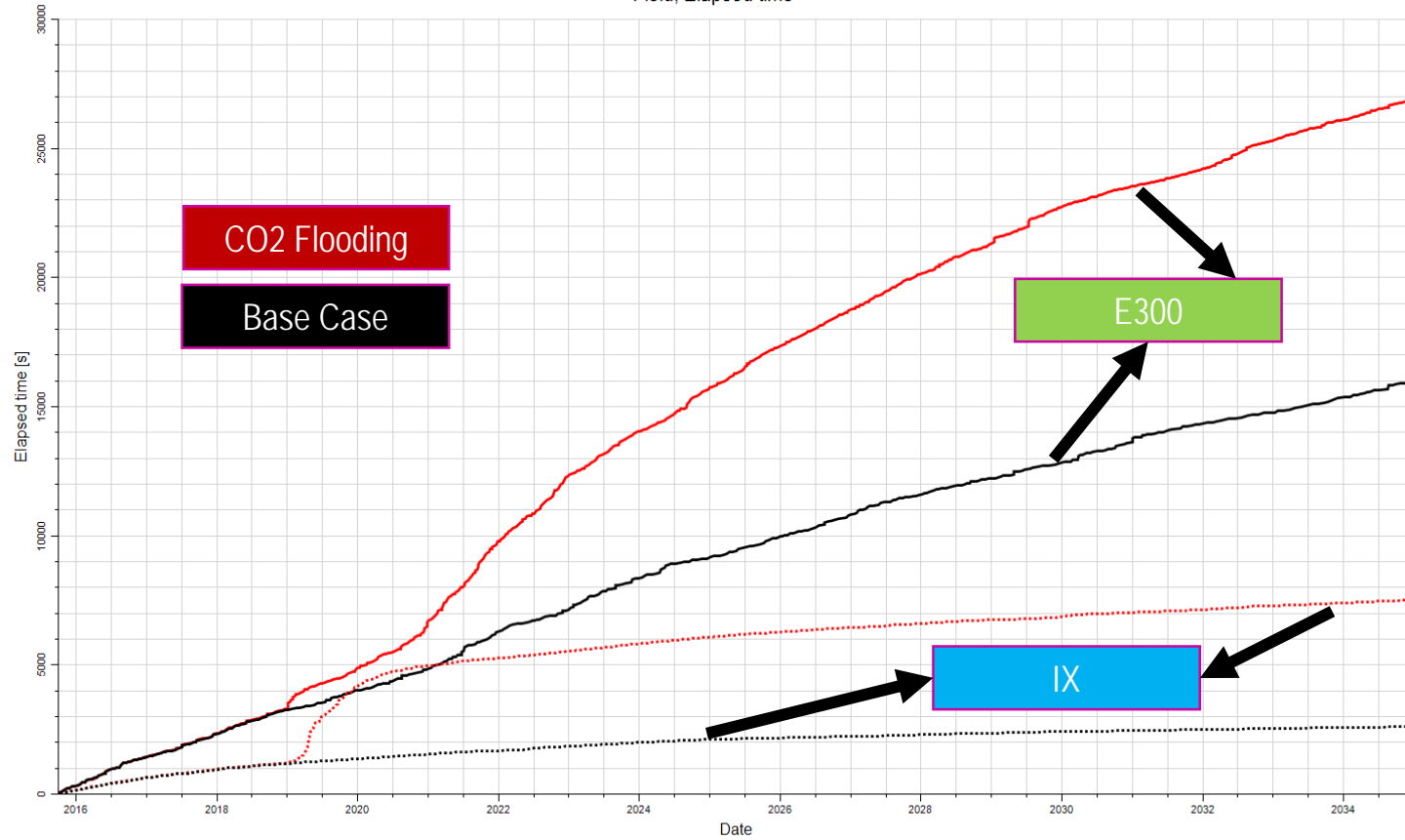
— 5C_PART_IX_RESTART_BC_2035, Oil production cumulative
 — 5C_PART_IX_RESTART_BC_2035, Oil production rate
 — 5C_PART_IX_RESTART_BC_CO2_2035, Oil production cumulative
 — 5C_PART_IX_RESTART_BC_CO2_2035, Oil production rate
- - - - RS_5C-REV_CO_PART_7_E300_RST-BC, Oil production cumulative
 - - - - RS_5C-REV_CO_PART_7_E300_RST-BC, Oil production rate
 - - - - RS_5C-REV_CO_PART_7_E300_RST-BC-CO2, Oil production cumulative
 - - - - RS_5C-REV_CO_PART_7_E300_RST-BC-CO2, Oil production rate

Oil Production Performance Comparison (Basecase & CO2 Flooding) IX and E300

Field, Elapsed time

Note :

- Using Base Model For This Case
- Restart Model Used by 5 Components and 7 Parallel Case
- IX and E300



..... 5C_PAR7_IX_RESTART_BC_2035 5C_PAR7_IX_RESTART_BC_CO2_2035 — RS_5C-REV_CO_PAR7_E300_RST-BC — RS_5C-REV_CO_PAR7_E300_RST-BC-CO2

Elapsed Comparison (Basecase & CO2 Flooding) IX and E300

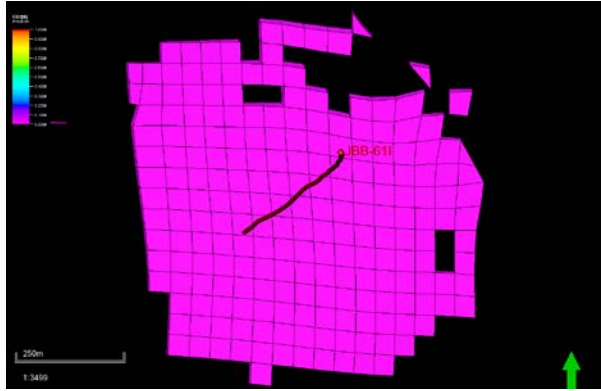
Elapsed Time Summary for All Cases in Forecasting Scenario in Whole Model

No	Cases	E300	IX	Reduction (Times)
		Elapsed (Hours)		
1	End of HM	3.33	1.15	2.89
2	Base Case	4.44	0.74	6.02
3	CO2 Flooding	7.48	2.10	3.57

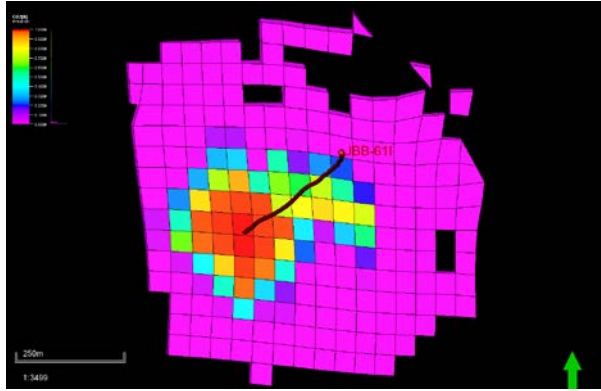
Oil Rate Production Average Error for All Cases in Forecasting Scenario in Whole Model

No	Cases	E300		IX	
		Np (MMSTB)	Gain Np (MMSTB)	Np (MMSTB)	Gain Np (MMSTB)
1	End of HM	37.75		34.74	
2	Base Case	48.78	Base Line	48.54	Base Line
3	CO2 Flooding	49.95	1.17	52.81	4.27

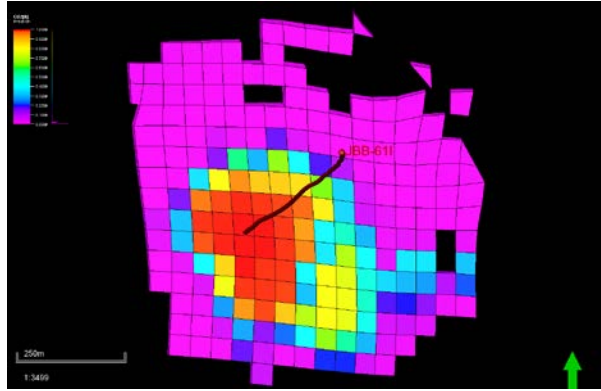
Map of CO2 Movement Profile for Certain Years (E300)



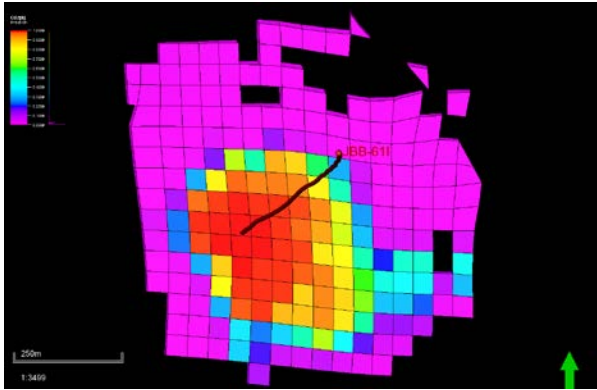
Oct 2015



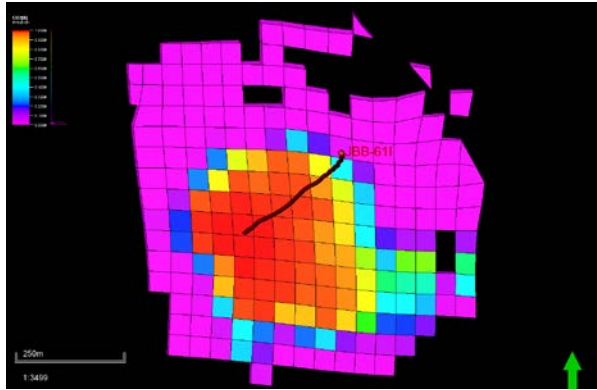
Jan 2020



Jan 2025



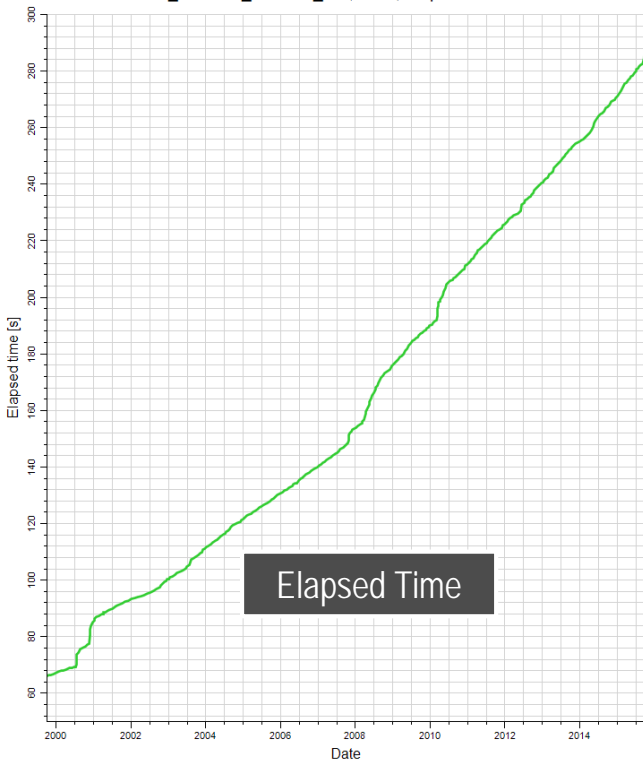
Jan 2030



Jan 2035

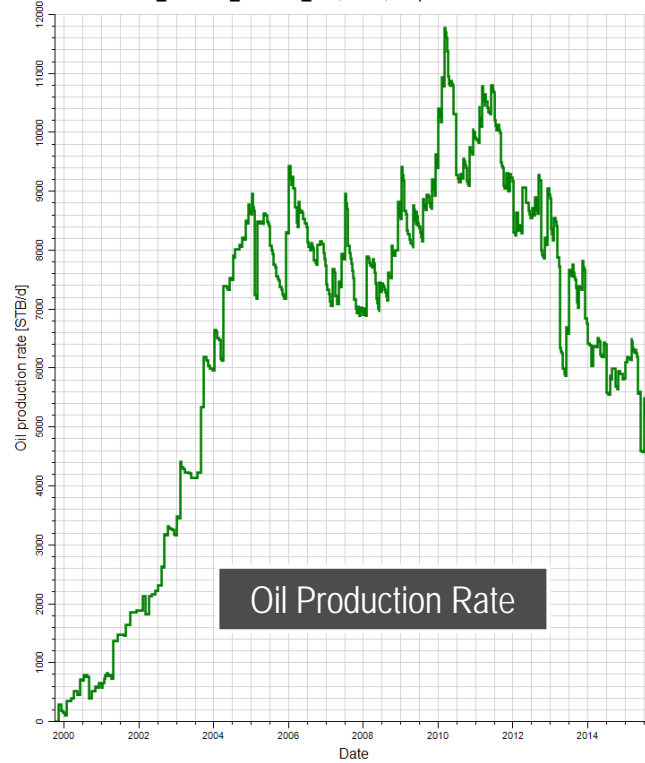
SECTOR MODELLING PHASE

RS_5C-REV_SERIAL_SM, Field, Elapsed time



Elapsed Time

RS_5C-REV_SERIAL_SM, Field, Oil production rate

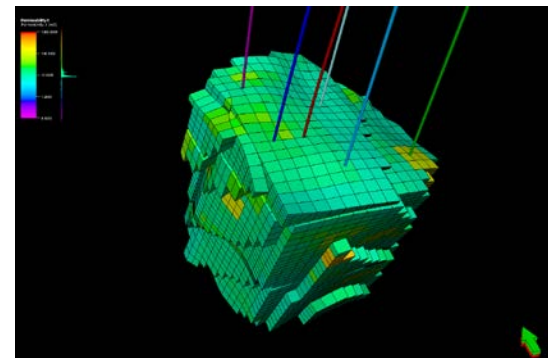


Oil Production Rate

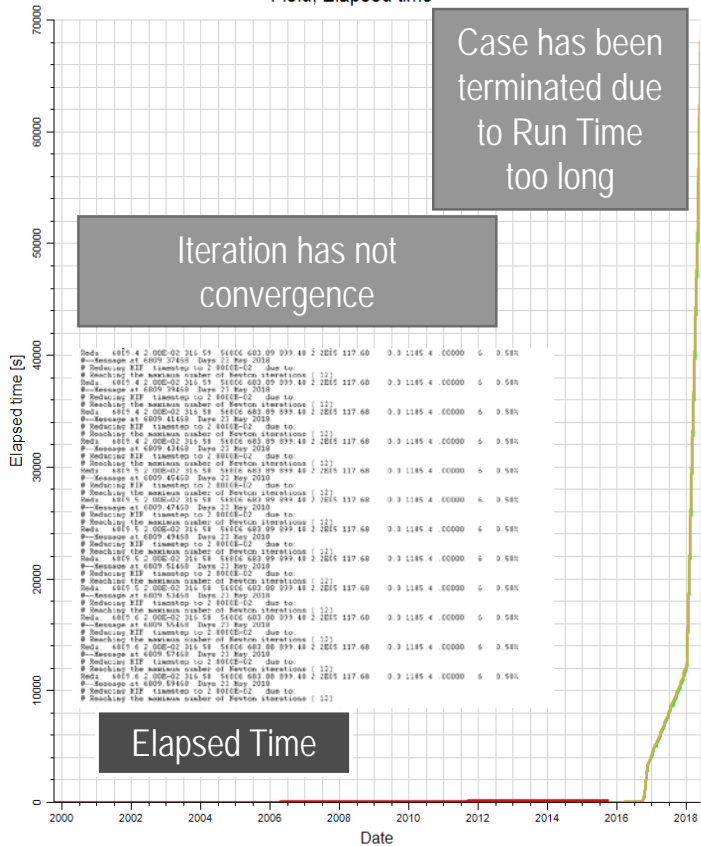
— Elapsed time — Oil production rate

Note :

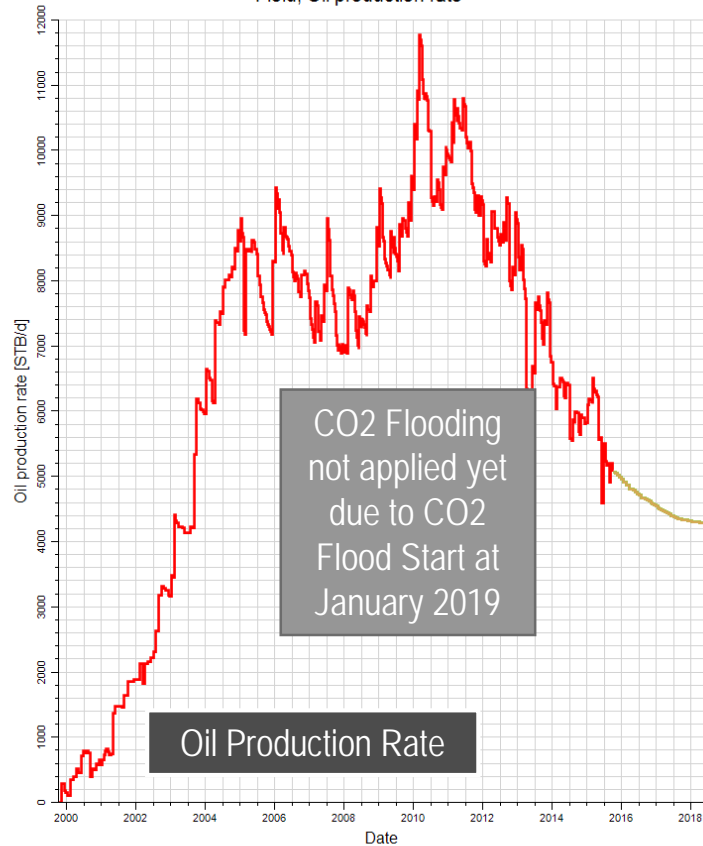
- Using Sector Model 50m x 50m For This Case
- Model Used by 5 Components and Serial Case
- E300



Field, Elapsed time



Field, Oil production rate



Note :

- Using Sector Model For This Case
- Model Used by 5 Components and Serial Case
- Forecasting Scenario Using CO2 and Base Case
- E300

Error has occurred while the case tried to run with parallel 7 cores in sector model (E300 Simulator)

```
Advancing simulation to 274.0 Days Cp/El/Mem:70.5/70.5/391Mb
@--Warning at 244.00000 Days 1 Jun 2000
@ CPR Solver Non-Linear Convergence problem
@ Residual too large by a factor of 1.7
@--Message at 244.00000 Days 1 Jun 2000
@ Reducing MaxW(Rep) timestep to 15.00 due to:
@--Message at 244.00000 Days 1 Jun 2000
@ Reducing MaxW(Rep) timestep to 15.00 due to:
@ Throughput 15.50668 > limit 1.00000
@--Message at 244.00000 Days 1 Jun 2000
@ Reducing MaxW(Rep) timestep to 15.00 due to:
@--Bug at 244.0000 Days 1 Jun 2000
@ Too many levels of storage management
@ IVEVFY_MY_MIEVFY= 20 20
@ Please check the simulator output and review any Warning, Error
@ and Problem messages. If the bug still persists please contact
@ the ECLIPSE support network
@ So far: 5 warnings, 7 problems, 0 errors, 1 bugs.
@ Please check the simulator output and review any Warning, Error
@ and Problem messages. If the bug still persists please contact
@ the ECLIPSE support network.
@ So far: 5 warnings, 7 problems, 0 errors, 1 bugs.
@--Error at 244.0000 Days 1 Jun 2000
@ Run stopping due to limit on bugs
@--Warning at 244.00000 Days 1 Jun 2000
@ CPR Solver Non-Linear Convergence problem
@ Residual too large by a factor of 1.1
Stopping due to limit on errors
176 Mbytes of storage required
149.5750 KB/active cell
128 Mbytes (image size)
```

```
Error summary
Comments 3
Warnings 6
Problems 7
Errors 1
Bugs 1
```

The run ended in NOSIM mode; check that your simulation is complete.

```
Final cpu 70.60 elapsed 70.60
Process CPU time Total storage Image size
1 70.6 176.3 Mb 127.8 Mb
2 70.5 63.1 Mb 81.6 Mb
3 70.5 63.1 Mb 76.2 Mb
4 70.5 63.0 Mb 76.4 Mb
5 70.6 65.3 Mb 77.7 Mb
6 70.5 63.0 Mb 75.5 Mb
7 70.5 391.1 Mb 138.6 Mb
Total number of time steps forced to be accepted 0
```

Note :

- Using Sector Model For This Picture
- Model Used by 5 Components and Parallel 7 Cores Case
- E300

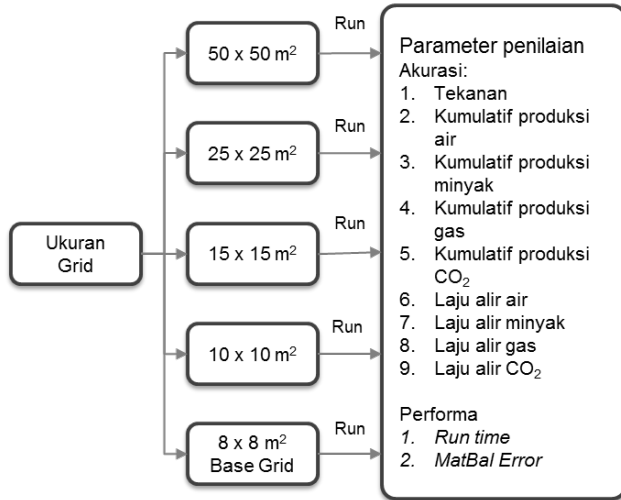
Forecasting Scenario Can not be Run due to Sector Model Can not be Run with 7 Parallel Cores

Note :

- Using Sector Model For This Picture
- Model Used by 5 Components and Parallel 7 Cores Case
- Forecasting Scenario Using CO2 and Base Case
- E300

LGR MODELLING IN SECTOR MODEL

OPTIMUM GRID DETERMINATION METHODOLOGY



Parameter		Weight	Peringkat berdasarkan galat terkecil			
			10 x 10	15 x 15	25 x 25	50 x 50
Akurasi (70%)	Kumulatif produksi CO ₂ -T	1	1	2	3	4
	Kumulatif Gas	1	2	1	3	4
	Kumulatif Minyak	1	1	2	3	4
	Kumulatif Air	1	2	1	3	4
	Laju produksi CO ₂ -T	1	1	3	2	4
	Laju Gas	1	1	3	2	4
	Laju Minyak	1	1	2	3	4
	Laju Air	1	2	1	3	4
	Tekanan	1	2	1	3	4
Parameter		Weight	Peringkat berdasarkan nilai			
			10 x 10	15 x 15	25 x 25	50 x 50
Performa (30%)	Elapsed Time	3	4	3	2	1
	Matbal Error	1	4	3	2	1
Skor			2.21	2.14	2.54	3.10



$$Skor = \frac{BB_A S_A + BB_P S_P}{BB_A + BB_P} \quad S_A = \frac{\sum_{n=1}^9 W_{A_n} N_{A_n}}{\sum_{n=1}^9 W_{A_n}} \quad S_P = \frac{\sum_{n=1}^2 W_{P_n} N_{P_n}}{\sum_{n=1}^2 W_{P_n}}$$

Keterangan :

BB_A = bobot akurasi

BB_P = bobot performa

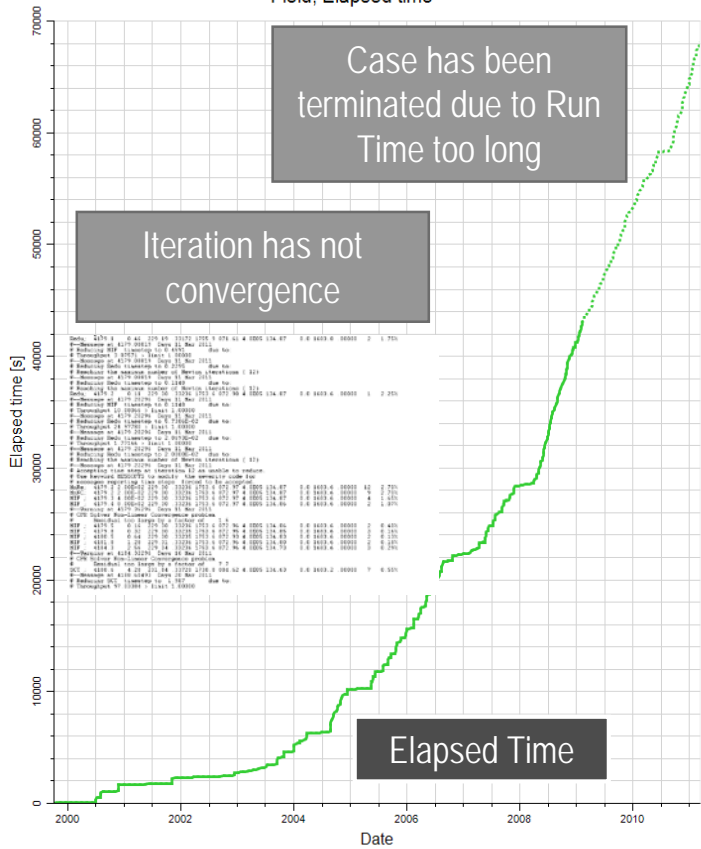
W_{A_n} = bobot akurasi parameter ke-n

W_{P_n} = bobot performa parameter ke-n

N_{A_n} = peringkat akurasi parameter ke-n

N_{P_n} = peringkat performa parameter ke-n

Field, Elapsed time

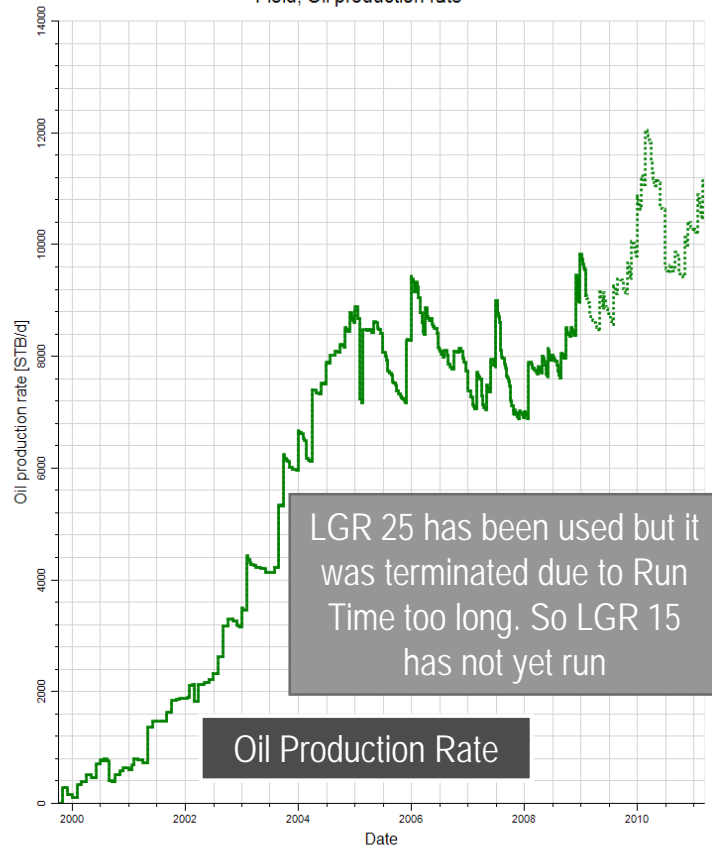


Case has been terminated due to Run Time too long

Iteration has not convergence

Elapsed Time

Field, Oil production rate



LGR 25 has been used but it was terminated due to Run Time too long. So LGR 15 has not yet run

Oil Production Rate

Note :

- Using Sector Model For This Case
- Model Used by 5 Components and Serial Case
- Forecasting Scenario Using Base Case and CO2 Flooding
- LGR Sensitivity (15, 25 and 50 M2) plan to be applied
- E300

— RS_SC-REV_SERIAL_SM_LGR25_FC-BC RS_SC-REV_SERIAL_SM_LGR25_FC-CO2 — RS_SC-REV_SERIAL_SM_LGR25_FC-BC RS_SC-REV_SERIAL_SM_LGR25_FC-CO2

Forecasting Scenario Can not be Run in 50 x 50 sector model then LGR with 25 x 25 also can't be run

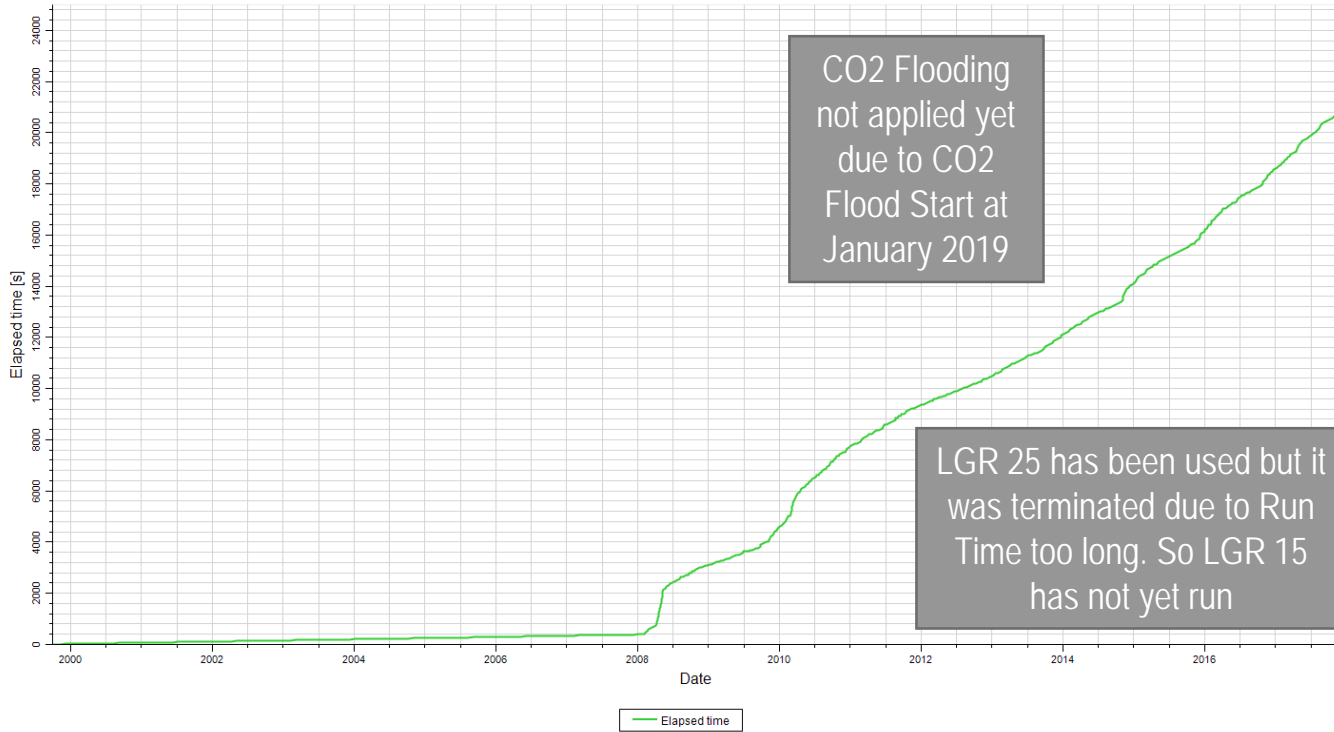
Elapsed Time

Oil Production Rate

Note :

- Using Sector Model For This Picture
- Model Used by 5 Components and Parallel 7 Cores Case
- Forecasting Scenario Using CO2 and Base Case
- LGR Sensitivity (15, 25 and 50 M2) applied
- E300

IX_CO2_25x25_7PAR, Field, Elapsed time



Note :

- Using Sector Model For This Case
- Model Used by 5 Components and Parallel 7 Cores Case
- Forecasting Scenario Using CO2 and Base Case
- LGR Sensitivity (15, 25 and 50 M2) applied
- IX

Run was stopped because it was too long, even though IX was used.

CONCLUSIONS

- ❖ Number of pseudo components not significantly affect the production performance but for simulator run time. The more number of pseudo components use, the simulator run time will be increase. 5, 7, and 9 numbers of pseudo components were used. 5 components was selected for this study.
- ❖ Dynamic model run using sensitivity number of pseudo components resulting very small deviation in the oil rate performance (less then 5 %) but in the runtime, using IX, reduced by 14 times (parallel 7) or 20 times (parallel 16) compared to serial E300.
- ❖ IX compositional gave the fastest runtime compare to Eclipse Compositional using same core number of parallel license.
- ❖ From scenario case result showed that IX gave more optimistic result in oil cumulative production profile about 3.1 MMSTB than E300.
- ❖ Grid optimization using LGR on sector model can't be done due to problems occure.

NEED TO BE ANALYSED MORE

- ❖ Difference production profile between E300 and IX with the same dataset.
- ❖ Messages on migration process in Petrel RE to IX need to be improved for user and how the impact of the partially migrated or Not Migrated keywords to IX dynamic model, for example DUMPFLUX.
- ❖ Sector model in Petrel RE using parallel license is not easily to be run. Need more information on how to define PSPLITX and PSPLITY.

SPECIAL THANKS TO

MY TEAM,

❖ RUDINI SIMANJORANG

SIS JAKARTA,

❖ YANUARIUS GANDUNG P

❖ M. ARIEF D

❖ RUDIYANTO

BACK UP

PVTi MODELLING

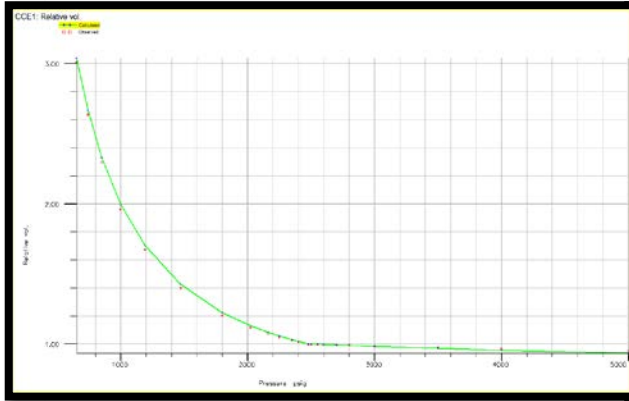
PRESSURE (PSIG)	RELATIVE VOLUME
5000	0.948
4000	0.9643
3500	0.9731
3000	0.9844
2800	0.9908
2700	0.9934
2600	0.9963
2550	0.9979
2500	0.9994
2480	1
2400	1.0158
2350	1.0265
2250	1.0499
2160	1.0737
2020	1.1166
1800	1.2028
1470	1.3975
1190	1.6711
1000	1.9614
850	2.2955
740	2.6356
650	3.006
CCE	

PRESSURE (PSIG)	OIL.REL.VOLUME (RB/STB)	GAS-OIL RATIO (MSCF/STB)	GAS DEV FACTOR Z	RES.OIL DENSITY (LB/CUFT)	GAS.REL.DENSITY	GAS.VOL.FACTOR (RB/MSCF)	LIQ.VIS CP	VAP.VIS CP
2480	1.7792	1.276		40.1724			0.3046	
2000	1.6339	1.013	0.7823	41.6395	0.9603	1.3875	0.3071	0.01879
1500	1.5088	0.785	0.8091	43.1752	0.9312	1.909	0.3389	0.01631
1000	1.3815	0.569	0.8462	45.1105	0.9606	2.9805	0.4125	0.01435
500	1.2602	0.362	0.9042	46.8647	1.1564	6.2785	0.5514	0.012
0	1.0921	0		47.6201	1.4333		0.8653	
DIFFERENTIAL LIBERATION								

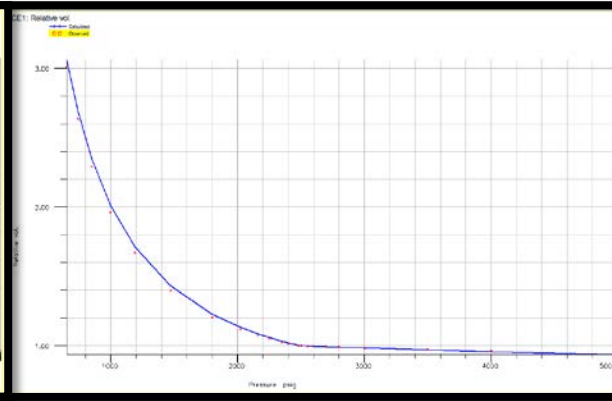
Components	ZI (Percent)	Weight Fraction (Percent)	Mol Weight (kg-mole)
	CO2	1.49	
C1	39.59		
C2	8.72		
C3	9.82		
IC4	2.29		
NC4	3.02		
IC5	1.18		
NC5	1.11		
C6	1.42		
C7+	31.36	209.9	0.8434
COMPOSITION			

EXPERIMENT DATA

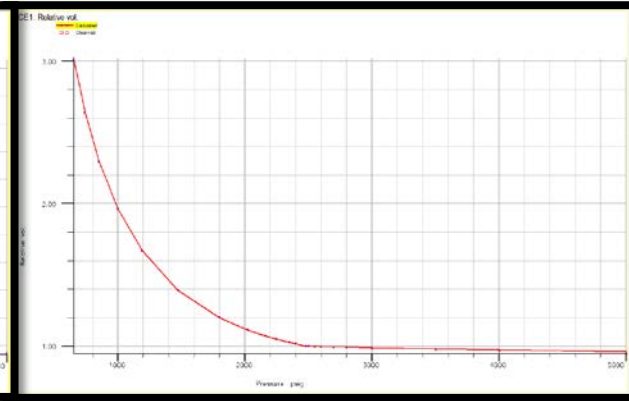
PVTi REGRESSION RESULT



5 Components



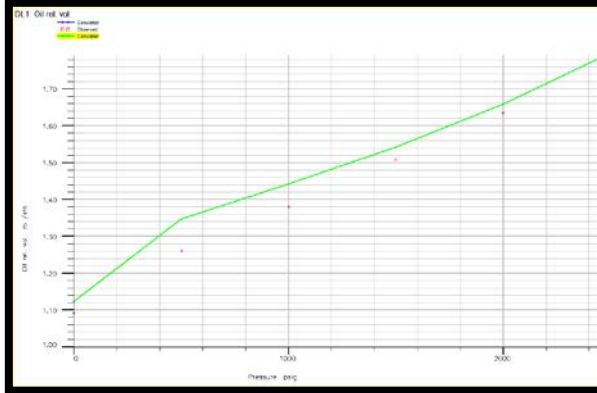
7 Components



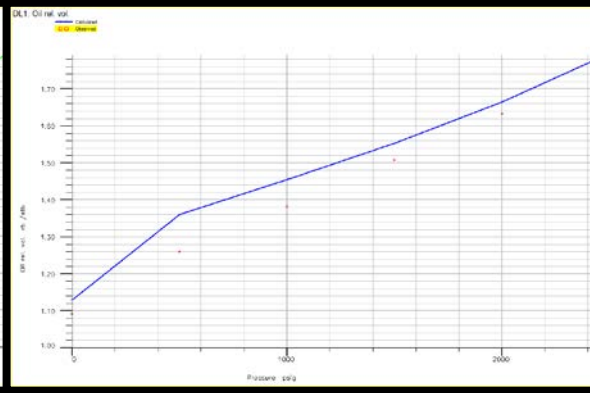
9 Components

RELATIVE VOL - CCE

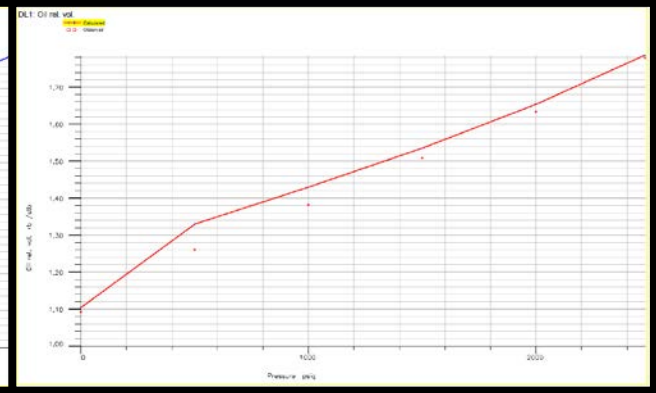
PVTi REGRESSION RESULT



5 Components



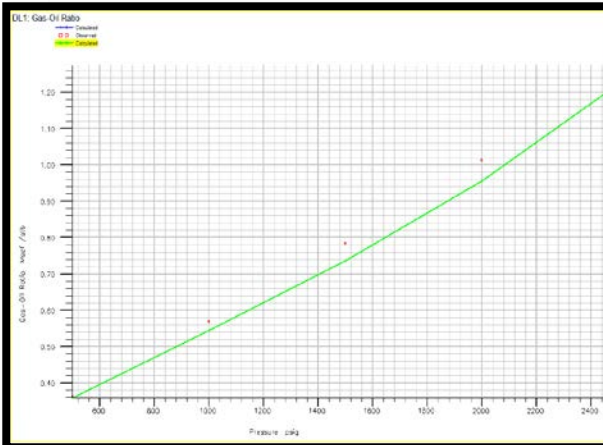
7 Components



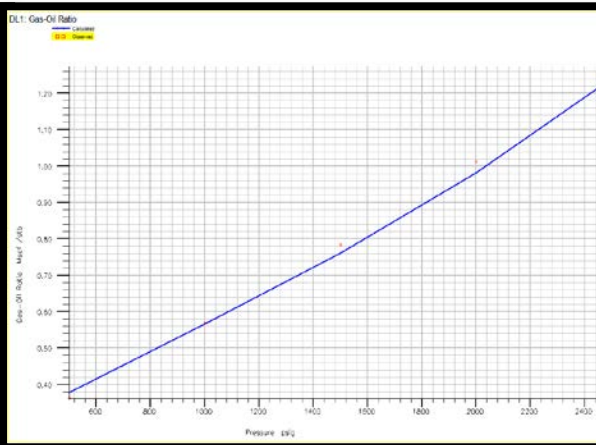
9 Components

OIL REL VOL - DL

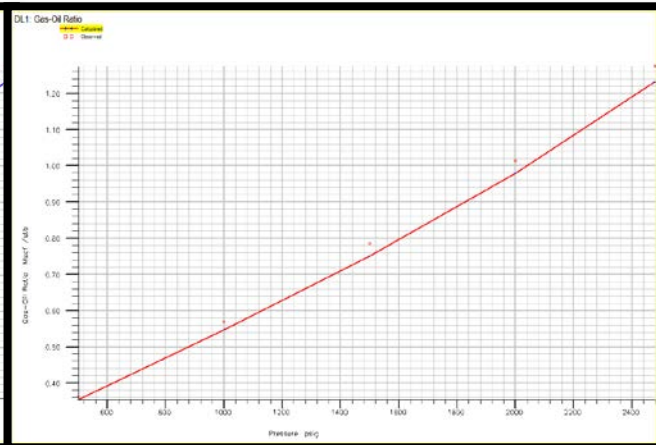
PVTi REGRESSION RESULT



5 Components



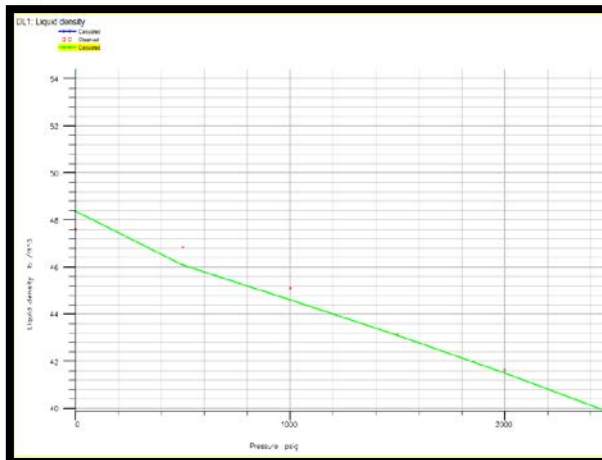
7 Components



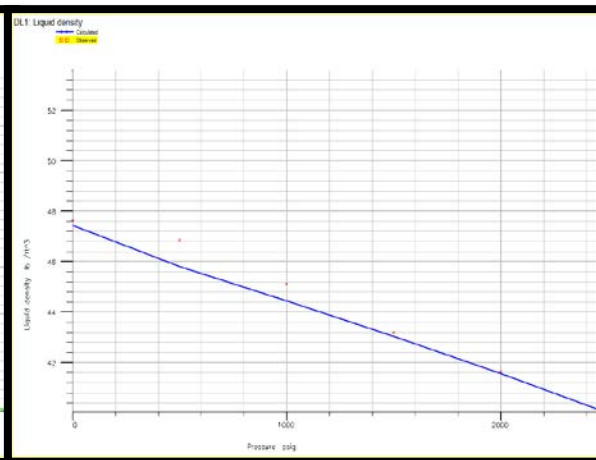
9 Components

GOR - DL

PVTi REGRESSION RESULT



5 Components



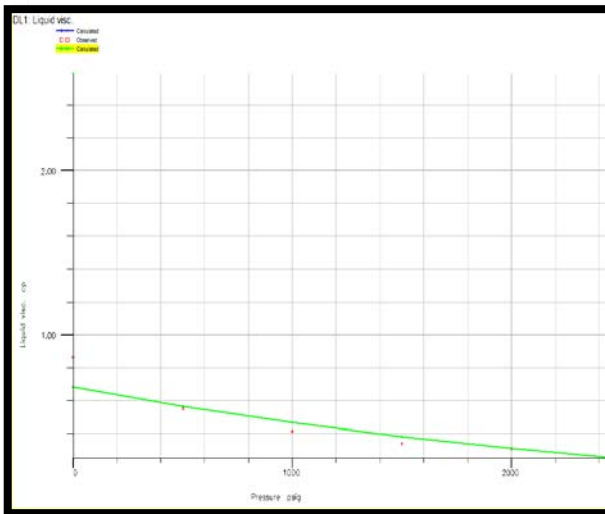
7 Components



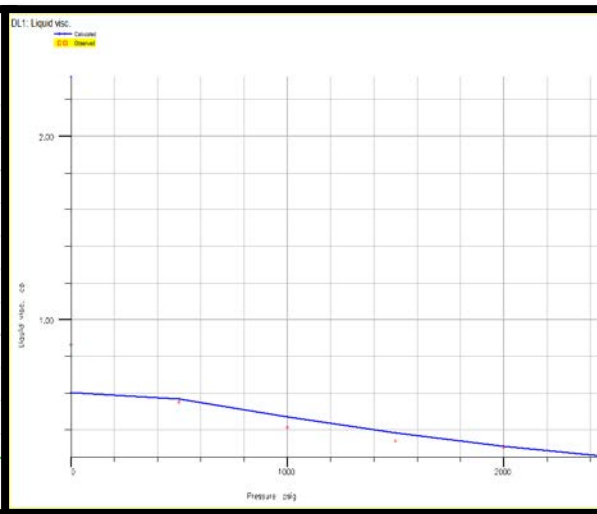
9 Components

LIQUID DENSITY - DL

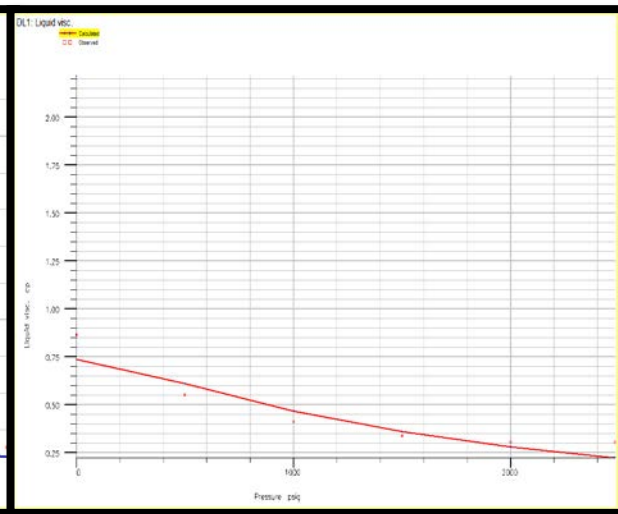
PVTi REGRESSION RESULT



5 Components



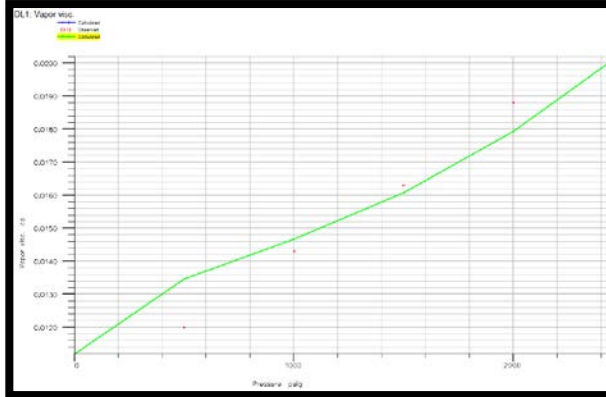
7 Components



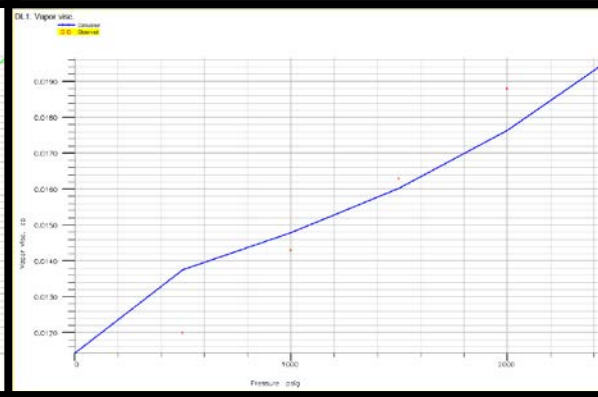
9 Components

LIQUID VISCOSITY - DL

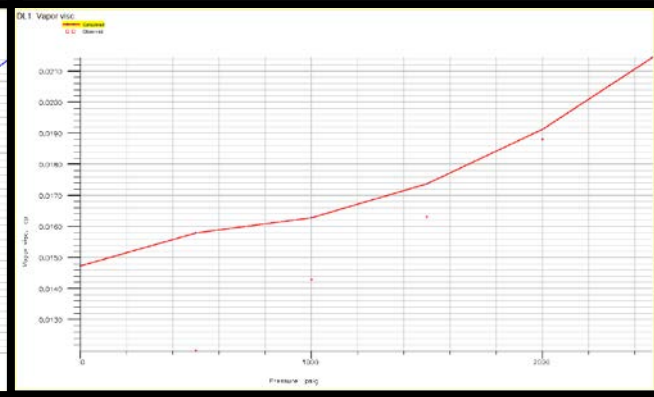
PVTi REGRESSION RESULT



5 Components



7 Components



9 Components

VAPOR VISCOSITY -
DL

Oil Rate Production Average Error (%) Calculation Example

SUMMARY OF RUN:	RS_5C-REV_CO_E300 : (Re-sampled)								
START DATE	Oct 02,1999								
NUMBER OF PARAMETERS:	1								
NUMBER OF TIMESTEPS:	16								
			5C-SERIAL	7C-SERIAL	9C-SERIAL				
Date	Time	Time	Field	Field	Field				
	Elapsed	Elapsed	Field	Field	Field				
	Years	Days	OPR	OPR	OPR				
			sm3/d	sm3/d	sm3/d				
						5 COMPONENTS	7 COMPONENTS	9 COMPONENTS	
						ERROR			
02-Oct-1999	0	0	0.00E+00	0.00E+00	0.00E+00	#DIV/0!	#DIV/0!	#DIV/0!	
02-Oct-2000	1	366	8.41E+01	8.52E+01	9.03E+01	0.00	1.28	7.37	
02-Oct-2001	2	731	2.97E+02	2.98E+02	3.02E+02	0.00	0.40	1.77	
02-Oct-2002	3	1096	5.31E+02	5.37E+02	5.49E+02	0.00	1.17	3.29	
02-Oct-2003	4	1461	9.97E+02	9.98E+02	1.01E+03	0.00	0.16	1.43	
02-Oct-2004	5	1827	1.31E+03	1.32E+03	1.35E+03	0.00	0.94	3.01	
02-Oct-2005	6	2192	1.18E+03	1.20E+03	1.25E+03	0.00	2.13	6.01	
02-Oct-2006	7	2557	1.29E+03	1.33E+03	1.38E+03	0.00	2.75	7.28	
02-Oct-2007	8	2922	1.15E+03	1.19E+03	1.24E+03	0.00	4.03	8.28	
02-Oct-2008	9	3288	1.29E+03	1.32E+03	1.37E+03	0.00	2.99	6.35	
02-Oct-2009	10	3653	1.40E+03	1.44E+03	1.48E+03	0.00	2.66	5.79	
02-Oct-2010	11	4018	1.46E+03	1.48E+03	1.50E+03	0.00	1.30	2.62	
02-Oct-2011	12	4383	1.45E+03	1.49E+03	1.52E+03	0.00	2.80	5.13	
02-Oct-2012	13	4749	1.28E+03	1.32E+03	1.35E+03	0.00	3.06	5.28	
02-Oct-2013	14	5114	1.18E+03	1.23E+03	1.25E+03	0.00	4.22	6.16	
02-Oct-2014	15	5479	9.08E+02	9.35E+02	9.63E+02	0.00	2.90	6.04	
					AVERAGE	0.00	2.19	5.05	

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