

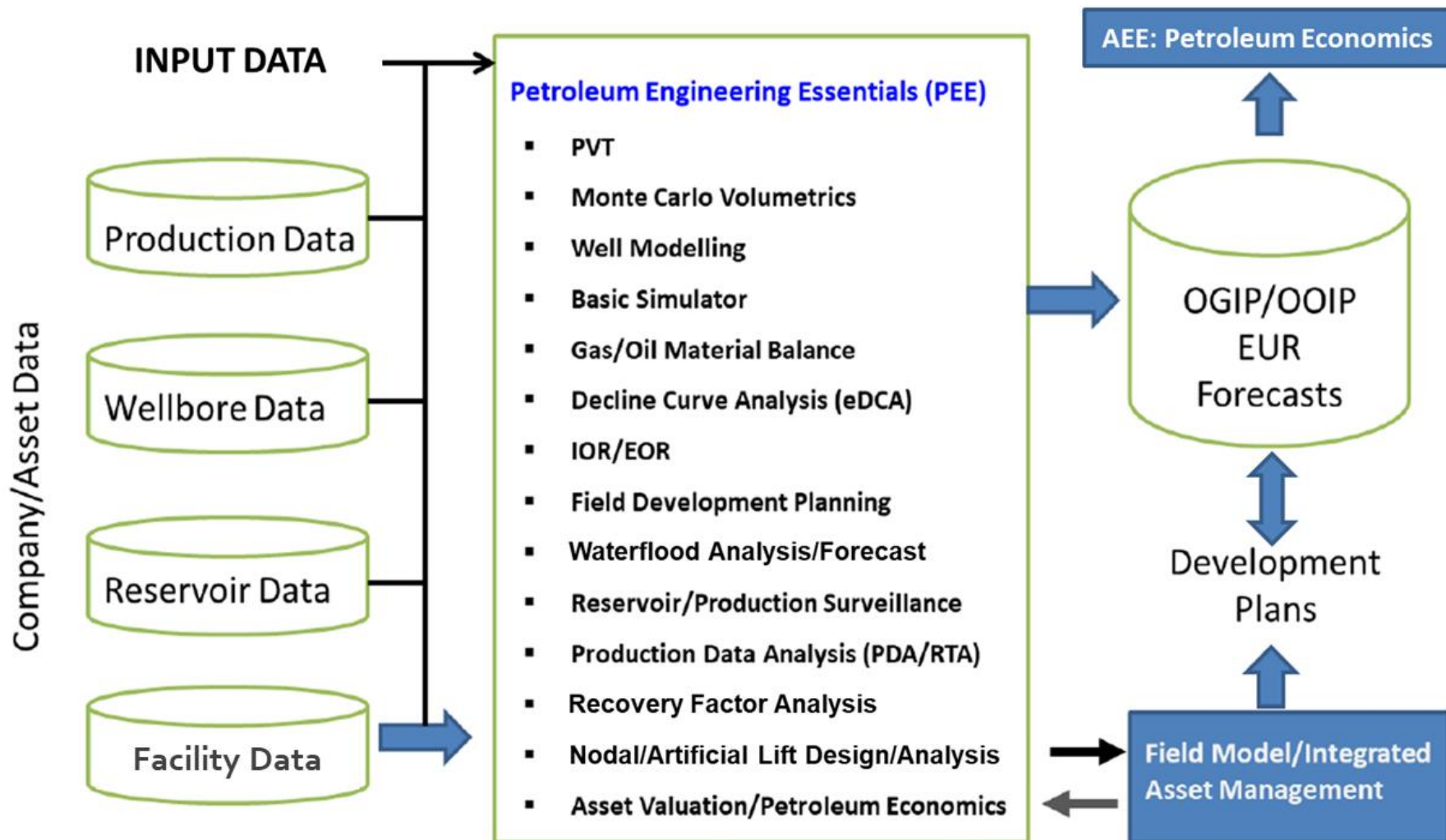


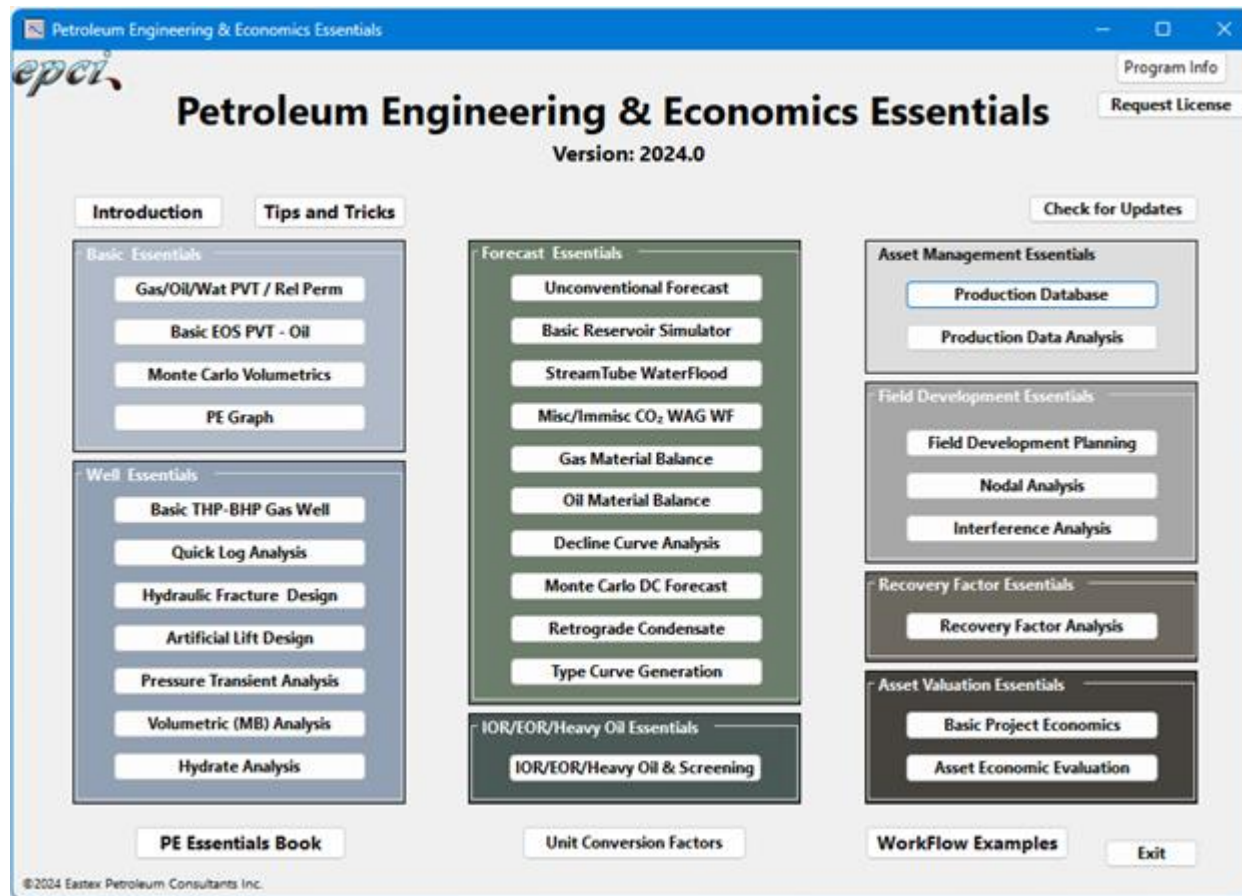
**EASTEX
PETROLEUM
CONSULTANTS Inc.**

Petroleum Engineering & Economics Essentials

**Tools and Techniques to Evaluate Unconventional (and Conventional)
Wells and Reservoirs**

Version 2024





Petroleum Engineering & Economics Essentials (PE² Essentials) is a comprehensive suite of cost-effective software tools comprised of Reservoir Engineering, Production Engineering and Economics programs.

The PE² Essentials suite of tools can be used for all types of wells/reservoirs: gas & oil; unconventional & conventional; onshore & offshore.



“Petroleum Engineering & Economics Essentials, Tools and Techniques to Evaluate Unconventional (and Conventional) Wells and Reservoirs” is a how-to manual for evaluation of oil and gas wells and reservoirs.

The book includes tools, theories, techniques and examples covering Reservoir Engineering, Production Engineering and Economics.

The book was originally conceived to be a handbook for evaluation of unconventional reservoirs but evolved to include conventional and some IOR/EOR evaluation techniques as well.

PE² Essentials

Version 2024

Asset Management Essentials

- Production Database (stores all raw production data and can be password protected)
- Production Data Analysis: PE Tools db, Flow Regime, RTA, Simulation (generates simulator data file)

Basic Essentials

- Gas/Oil/Water PVT and Relative Permeability Curve Generation (generates simulator PVT files)
- Basic Equation of State (EOS) Model for Oil - PR and SRK (generates equivalent black oil PVT simulator tables)
- Monte Carlo Simulation for Oil and Gas In-Place and Recoverable Volumes
- PE Graph (plots data from PE² Essentials; CSV files; or simulator RSM files)

Well Essentials

- THP-BHP Tubing Pressure Drop Calculations for Gas Wells
- Quick Log Analysis – Includes GIIP/OOIP and TOC Estimates, also includes pressure-depth (RFT) analysis
- Hydraulic Fracture Design
- Artificial Lift Design (rod pump, plunger lift, hydraulic pump and ESP)
- Pressure Transient Analysis and Analytical Test Pressure Simulator (9 Reservoir Configurations)
- Volumetric Surveillance and Analysis (includes Drive analysis)
- Hydrate Analysis (gas gravity and compositional analysis and includes inhibitor volume forecast)

Forecast Essentials

- Horizontal Hydraulically Fractured Well Forecasting (includes a History Matching Simulation tool)
- Basic Reservoir Simulator – Single Well Reservoir Simulator (generates simulator data file)
- Streamline WaterFlood Simulator (Leighton and Higgins streamline simulator)
- Miscible/Immiscible CO₂ WAG and Waterflood Streamline Simulator (DOE)
- Multi-Tank Gas Material Balance and Oil Material Balance Analysis and Forecast (includes aquifers)
- Decline Curve Analysis and Forecast (Deterministic Forecast) includes eDCA and NormDCA
- Monte Carlo Decline Curve Production Forecasting (Probabilistic Forecast)
- Type Curve Generation (averaging and probabilistic type curves based on history and Arps parameters)

IOR/EOR/Heavy Oil Essentials

- IOR/EOR Screening Tool (screens 18 different processes)
- IOR/EOR/Heavy Oil Tools (MMP, Thermal Properties, Hot/Cold Injection, Pump Rates)

Field Development Essentials

- Field Development Planning (Multi-well Project Planning and Forecasting)
- Nodal Analysis: Reservoir, Wellbore, Surface, Compressors and Artificial Lift (generates simulator VFP files)
- Interference Analysis: Performs well-to-well interference analysis of production data

Recovery Essentials

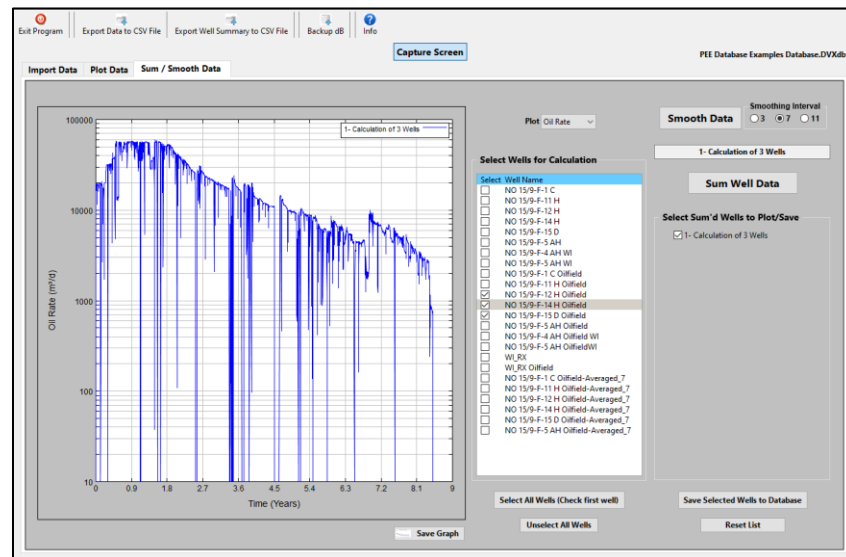
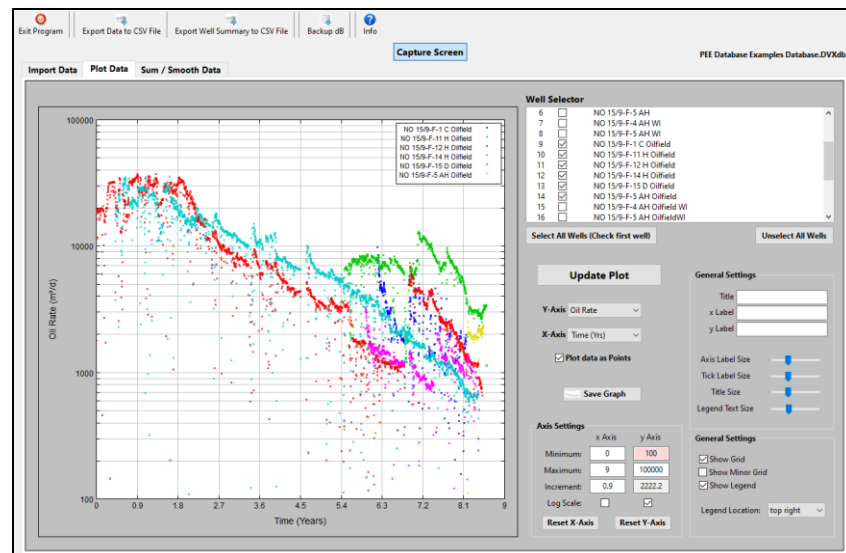
- Recovery Factor Analysis – Monte Carlo Oil, Gas, Unconventional, Reservoir Complexity, ANN

Asset Valuation Essentials

- Project Economics (Includes Corporate Economics Model)
- Asset Economic Evaluation (includes Generic, TSC, PSC contracts and acquisition analysis)

Production Database Tool

- This is the repository for all production data
- The database can be password protected
- Can perform data smoothing of noisy data



PEE Database Examples Database.DVXdb

Import Data Plot Data Sum / Smooth Data

Open Database Import Parameters

New Database Units Fluid Type

Excel Input Oilfield Oil

Link CSV File Metric Gas

Well Info: NO 15/9-F-12 H Offfield

Well Type: Producer Gnj Winj

Excel Input Parameters

Date (Format = mm/dd/yyyy) Column Letter

Well Name (Multi-Well Import) Start Row

Oil/Cond Prod (bbls) End Row (optional)

Gas Prod (mmscf)

Water Prod (bbls)

Tubing Head Pressure (psi)

Casing Head Pressure (psi)

Bottomhole Pressure (psi)

Water Injection (bbls)

Gas Injection (mmscf)

Well Comments

User Data 1 User Data 3

User Data 2 User Data 4

Import Data / Save to Database

Date	Days	Oil Prod	Gas Prod	Water Prod	THP	CHP	BHP
11-Feb-08	0	0	0	0	0	0	0
12-Feb-08	1	1.790448	1.37334	2.421713	1753.34	238.8283	4395.128
13-Feb-08	2	11.76041	10.07337	0.0448477	1753.34	238.8283	4395.128
14-Feb-08	3	19.65053	18.00889	0.0072964	1649.342	183.6117	4287.112
15-Feb-08	4	16.40608	13.54059	0.0061013	1694.485	76.34859	4317.231
16-Feb-08	5	19.19582	14.77827	0.0307581	1674.235	179.6229	4292.18
17-Feb-08	6	18.76074	14.92973	0.0116365	1670.919	208.6204	4286.613
18-Feb-08	7	18.74747	14.6143	0.0407592	1643.013	231.7767	4267.169
19-Feb-08	8	19.16054	15.15769	0.0045917	1650.081	272.8341	4261.631
20-Feb-08	9	19.22986	15.84379	0.0028934	1644.723	286.3154	4250.496
21-Feb-08	10	19.06078	14.96668	0.0028305	1640.468	281.8325	4242.936
22-Feb-08	11	18.28855	14.04846	0.0027676	1640.076	15.06351	4240.344
23-Feb-08	12	11.64732	8.902051	0.0017612	1633.164	159.6987	4236.383
24-Feb-08	13	19.66694	15.63762	0.0029563	1612.629	124.4817	4213.948
25-Feb-08	14	19.15645	15.59042	0.0028934	1616.441	178.4597	4209.112
26-Feb-08	15	19.16274	15.7823	0.0028934	1608.954	181.39	4199.366
27-Feb-08	16	19.09355	15.73678	0.0028934	1600.136	179.4945	4190.621
28-Feb-08	17	18.69105	14.99722	0.0028305	1604.533	147.206	4189.388
29-Feb-08	18	19.3137	15.90389	0.0028934	1587.393	165.6903	4170.041
01-Mar-08	19	19.30074	15.80628	0.0028934	1578.399	161.7972	4161.009
02-Mar-08	20	19.28854	15.75543	0.0028934	1571.063	162.7705	4151.916
03-Mar-08	21	19.14387	15.67004	0.0028934	1567.266	157.605	4144.131
04-Mar-08	22	18.76427	15.19402	0.0028305	1567.496	142.5567	4139.114
05-Mar-08	23	18.66274	15.45681	0.0028305	1564.511	135.2153	4131.092
06-Mar-08	24	18.56104	15.28161	0.0109446	1556.405	132.1817	4123.345
07-Mar-08	25	16.71014	13.81738	0.0098753	1562.835	91.02382	4125.215
08-Mar-08	26	16.21864	12.91701	0.0095608	1566.863	66.58511	4125.062
09-Mar-08	27	18.85006	15.1073	0.011333	1536.377	124.4675	4095.662
10-Mar-08	28	19.00461	15.96243	0.003774	1527.097	130.7047	4083.134
11-Mar-08	29	19.93542	15.92593	0.003774	1520.151	129.5643	4074.028
12-Mar-08	30	17.57703	14.79285	0.0035224	1523.662	97.10792	4076.79
13-Mar-08	31	19.24042	16.19262	0.0038369	1500.289	125.3234	4053.632
14-Mar-08	32	18.64665	15.11521	0.0037111	1497.071	113.4038	4046.173
15-Mar-08	33	19.69632	16.0377	0.0039627	1481.415	127.899	4031.338
16-Mar-08	34	19.72148	16.06104	0.0039627	1475.6	121.9838	4021.786
17-Mar-08	35	19.7718	16.60637	0.0039627	1469.218	116.1214	4011.226
18-Mar-08	36	19.70261	15.01878	0.0039627	1463.587	112.4508	4002.79
19-Mar-08	37	19.74821	16.03615	0.0039627	1457.046	108.4287	3993.799
20-Mar-08	38	19.85545	16.5084	0.0039627	1452.179	101.0636	3985.53

List Database Info

Select Well: NO 15/9-F-12 H Offfield

Delete Well

Change Well Name

Append Well Data

Reload Well Data

Edit Data

Select well/row before choosing edit

Edit Table Data

Table Display Units

Oil bbls Gas mmscf

Oil mmbbls Gas Bscf

Water bbls Pressure psi

Water mmbbls

Production Data Analysis (PDA) Tool (1)

- Links to, and loads, data from the Production Database and creates an integrated PE Tools database
- The PE Tools Database is the repository for all tool models and forecasts
- Database Management enables viewing and deleting the contents of the database

Exit Program

Load PE Tools dBase

Link to PE Production dBase

Convert Forecast

Export Data to CSV File

Save Well Data to New dBase

Create New (Empty) dBase

Copy dBase

Backup dB

Info

PEE Tools Examples Database.PEEdb

Database Management

Oilfield Units

Oil Well

Capture Screen

INTERPRET-PDA

INTERPRET-PDA WFlood

INTERPRET-PDA WI

Update Wells to Database

Production Data

PVT

Data Validation / Diagnostics

Flow Regime Identification

Flowing Material Balance Analysis

Analytical Simulator

Numerical Simulator

Eagle Ford Example

☒ Check=Raw Import Data / ☐ UnCheck=Analyzable Data

☒ Show Rate
 ☐ Show Cum

Data to be imported from the PE Production Database:

#	Sel	Well Name	P/I
1	<input type="checkbox"/>	NO 15/9-F-1 C	P
2	<input type="checkbox"/>	NO 15/9-F-11 H	P
3	<input type="checkbox"/>	NO 15/9-F-12 H	P
4	<input type="checkbox"/>	NO 15/9-F-14 H	P
5	<input type="checkbox"/>	NO 15/9-F-15 D	P
6	<input type="checkbox"/>	NO 15/9-F-5 AH	P
7	<input type="checkbox"/>	NO 15/9-F-4 AH WI	I
8	<input type="checkbox"/>	NO 15/9-F-5 AH WI	I
9	<input type="checkbox"/>	NO 15/9-F-1 C Oilfield	P
10	<input type="checkbox"/>	NO 15/9-F-11 H Oilfield	P
11	<input type="checkbox"/>	NO 15/9-F-12 H Oilfield	P
12	<input type="checkbox"/>	NO 15/9-F-14 H Oilfield	P
13	<input type="checkbox"/>	NO 15/9-F-15 D Oilfield	P
14	<input type="checkbox"/>	NO 15/9-F-5 AH Oilfield	P
15	<input type="checkbox"/>	NO 15/9-F-4 AH Oilfield WI	I
16	<input type="checkbox"/>	NO 15/9-F-5 AH OilfieldWI	I
17	<input type="checkbox"/>	WI_RX	I
18	<input type="checkbox"/>	WI_RX Oilfield	I
19	<input type="checkbox"/>	NO 15/9-F-1 C Oilfield-Averaged_7	P
20	<input type="checkbox"/>	NO 15/9-F-11 H Oilfield-Averaged_7	P
21	<input type="checkbox"/>	NO 15/9-F-12 H Oilfield-Averaged_7	P
22	<input type="checkbox"/>	NO 15/9-F-14 H Oilfield-Averaged_7	P
23	<input type="checkbox"/>	NO 15/9-F-15 D Oilfield-Averaged_7	P
24	<input type="checkbox"/>	NO 15/9-F-5 AH Oilfield-Averaged_7	P

Select 25 Wells (Check first well)

Unselect All Wells

Import Data From PE Production dBase

Update Prod Data From PE Production dBase

Save New Data to PE Tools dBase

Date	Days	Oil Rate	Gas Rate	Water Rate	THP	CHP	BHP
31-Jul-12	1	42.99955	1119.988	554.9942	0	3857	6191.7
1-Aug-12	2	53.58936	1410.983	537.9935	0	4075	6326.5
2-Aug-12	3	58.99998	1608.999	429.9998	0	4179	6355.6
3-Aug-12	4	73.99997	1805.999	340.9999	0	4288	6394.9
4-Aug-12	5	72.99997	1933.999	291.9999	0	4300	6354.6
5-Aug-12	6	92.99996	2254.999	240.9999	0	4300	6252.3
6-Aug-12	7	88.99996	2201.999	205.9999	0	4275	6224.3
7-Aug-12	8	44.99998	1330.999	110	0	4225	6410.8
8-Aug-12	9	93.99996	2529.999	210.9999	0	4225	6078.7
9-Aug-12	10	105	2432.999	130.9999	0	4225	6075.1
10-Aug-12	11	139.9999	2561.999	161.9999	0	4150	5471.8
11-Aug-12	12	98.99996	2608.999	158.9999	0	4067	5326.8
12-Aug-12	13	34.09999	850.9996	51.69998	0	4217	6571
13-Aug-12	14	53.99998	1249.999	80.99997	0	4192	6402.7
14-Aug-12	15	0	0	0	0	0	0
15-Aug-12	16	0	0	0	0	0	0
16-Aug-12	17	0	0	0	0	0	0
17-Aug-12	18	0	0	0	0	0	0
18-Aug-12	19	62.99997	1844.999	55.99998	0	4200	6179.9
19-Aug-12	20	59.99998	1530.999	53.99998	0	4329	6434.4
20-Aug-12	21	127.9999	3081.999	120	0	4100	5322.3
21-Aug-12	22	115	2866.999	101	0	4050	5258.6
22-Aug-12	23	96.99996	2740.999	103	0	4000	5192.7
23-Aug-12	24	120	2717.999	81.99997	0	3933	5126.8
24-Aug-12	25	117	2714.999	82.99997	0	3904	5091.3
25-Aug-12	26	124.9999	2700.999	80.99997	0	3850	5037.7
26-Aug-12	27	121.9999	2710.999	73.99997	0	3810	4981.9
27-Aug-12	28	128.9999	2714.999	71.99997	0	3894	5084.4
28-Aug-12	29	121.9999	2618.999	68.99997	0	3900	5088.6
29-Aug-12	30	117	2602.999	65.99997	0	3900	5081.2
30-Aug-12	31	120	2604.999	66.99997	0	3875	5057
31-Aug-12	32	107	2560.999	62.99997	0	3850	5012.4

Note: Rate in mscf/d, bbls/d and Pressure in psi

Edited data, Cum Reduction ==> 0

Generate BHP

Clear Well BHP

ReLoad dBase

Clear All BHP's

Base Well

Eagle Ford Example

Reservoir Parameters

Reservoir Pressure (psi)

7000

Reservoir Temp (°F)

160

Average Porosity (dec)

0.057

Average Perm (md)

1

Average Pay (ft)

50

Wellbore radius (in)

4

Gas Saturation (dec)

0

Oil Saturation (dec)

0.73

Water Saturation (dec)

0.27

Initial OIP (mmbbls)

0.531

ΔP/AOF Parameters

☐ Use THP
 ☐ Use CHP
 ☒ Use BHP

ΔP ==> P_i =

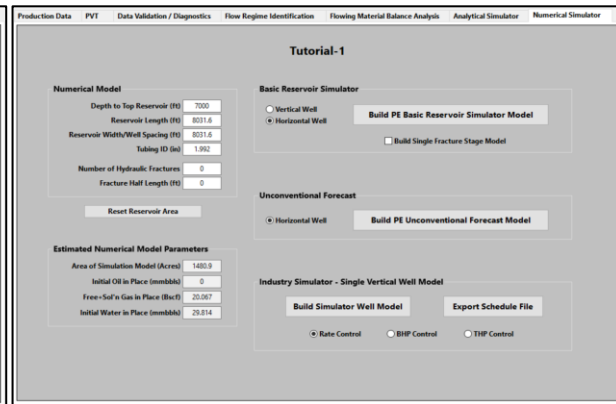
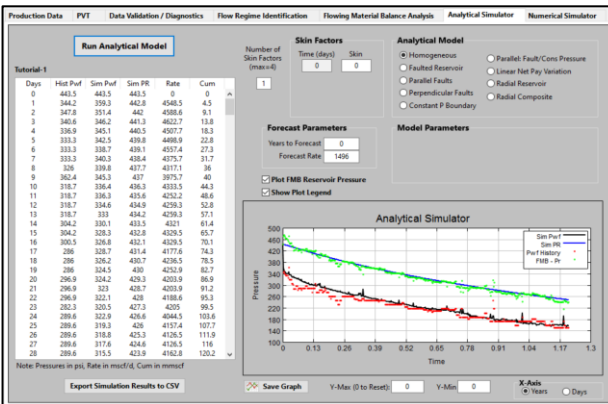
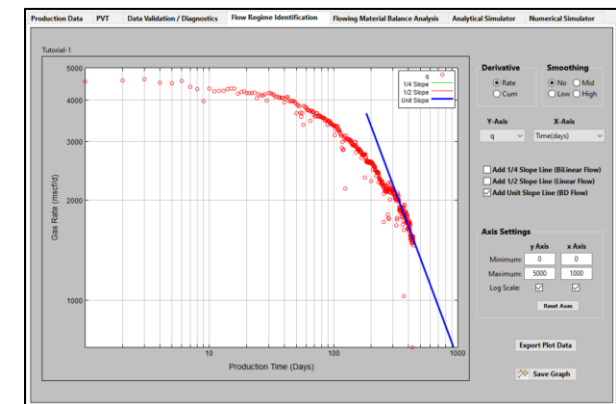
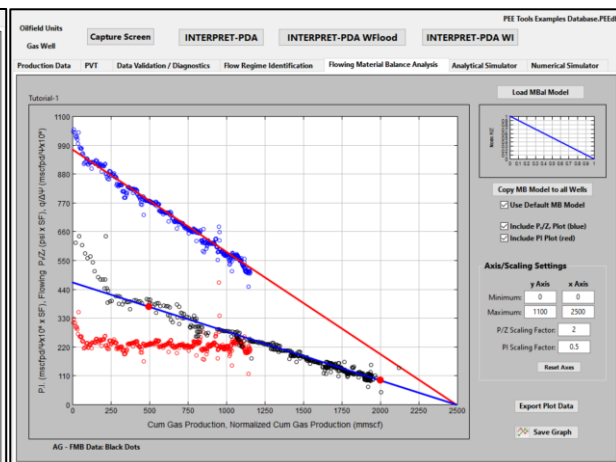
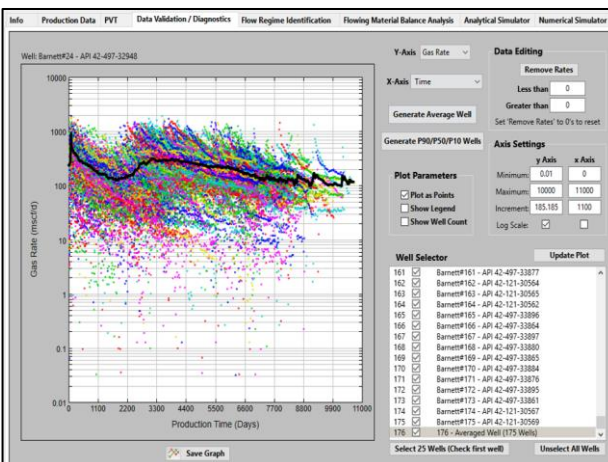
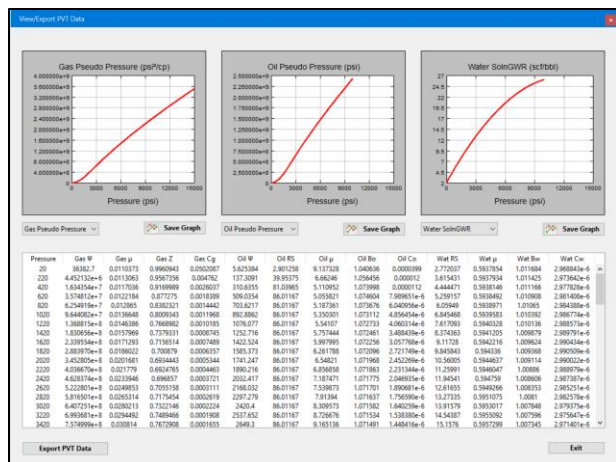
7000

☐ Use Pseudo Pressure

Copy Res Parameters to all Wells

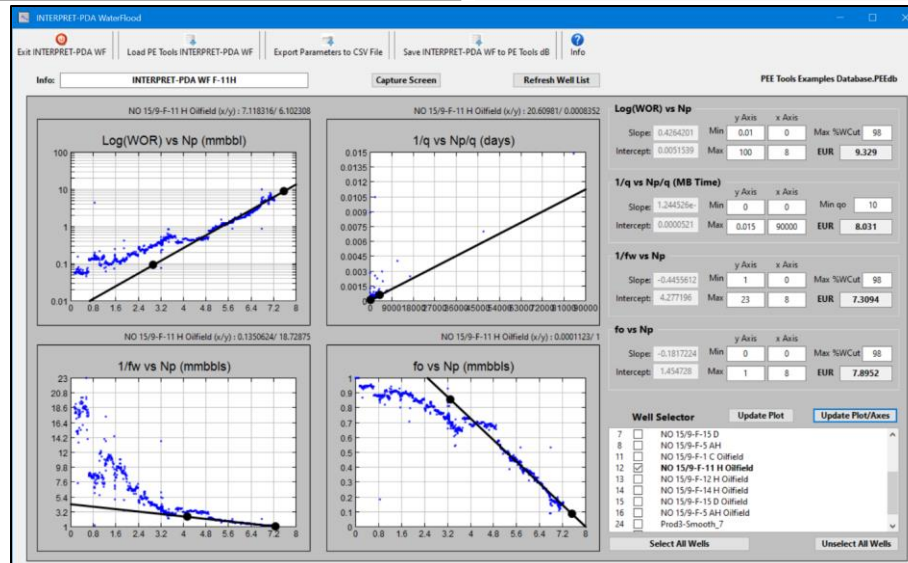
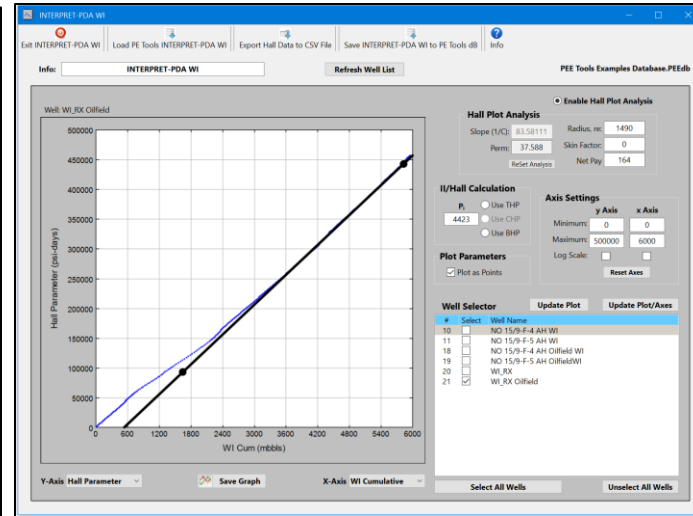
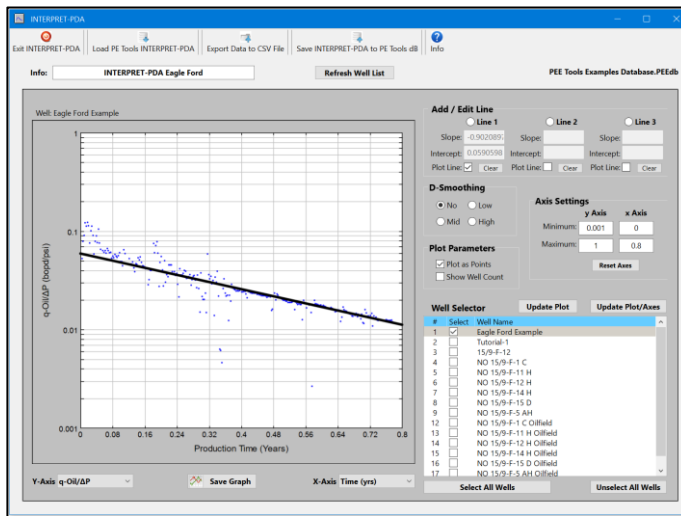
Production Data Analysis (PDA) Tool (2)

- Generates PVT tables or imports tables from the PE Essentials PVT tool
- Includes oil and gas Flowing Material Balance
- Can generate P90/P50/P10 and average curves from multiple wells
- Can assist with identifying flow regimes to identify boundary dominated flow
- Includes an Analytical Simulator
- Generates a model for the Basic Reservoir Simulator tool and the industry standard reservoir simulator



Production Data Analysis (PDA) Tool (3)

- INTERPRET-PDA tool performs straight-line analysis of any plot
- INTERPRET-PDA WI tool performs a Hall Plot analysis of water injection well data
- INTERPRET-PDA Wflood tool performs a straight-line analysis of oil-water performance in order to estimate the waterflood EUR for a given water cutoff



- Gas/Oil/Water PVT and Relative Permeability Curve Generation (exports simulator PVT files)
- Basic Equation of State (EOS) Model for Oil (exports equivalent black oil simulator PVT file)
- Monte Carlo Simulation for Oil and Gas In-Place and Recoverable Volumes

Exit Program Load PE Tools PVT Model Oil Rel Perm Gas Rel Perm Export Tables to CSV Save to PE Tools dBase Info

Oilfield Open PE dB

Generate Oil PVT Tables

Generate Gas PVT Tables

Generate Water/Rock PVT Tables

Generate Pseudo Gas Composition

Generate Pseudo Oil Composition

Gas Properties

Gas P _c	662.4	psia
Gas T _c	436.7	°R
Z	0.817	<>
Gas Compressibility	28.991	x10 ¹⁷ /psi
Gas Viscosity	0.0236	cp
Gas Expansion (1/Bg)	188.7	scf/ft ³
Initial CGR (R)	0	bbbl/mmscd

Water Properties

Water Density	1.0213	g/cc
Solution RSW	0.361	x10 ¹⁷ /psi
Water Compressibility	0.334	x10 ¹⁷ /psi
Water Viscosity	0.289	cp
Bw	1.0421	bbbl/sbbl
G/W Interfacial Tension	45.4	Dynes/cm
O/W Interfacial Tension	2.32	Dynes/cm

Oil Properties

Reservoir Pressure	2965	psia
Bubble Point Pressure	2741.7	psia
Solution GOR @ PR	768	scf/bbl
Oil Viscosity	0.339	cp
Bo	1.444	bbbl/sbbl

Rock Properties

Reservoir Pressure	2965	psia
Rock Compressibility	0.361	x10 ¹⁷ /psi
Total Compressibility	10.085	x10 ¹⁷ /psi
Estimated Oil Perm	100	md
Estimated Gas Perm	10	md

Update PVT Properties

Gas Parameters

Gas Gravity	0.855
%H ₂ S	0
%CO ₂	0
%N ₂	0
CGR	Info

Oil Parameters

Oil API	40.7
Solution GOR	768
Bubble Point Pressure	2741.7

Rock/Water Parameters

Salinity (ppm NaCl)	30000
Porosity (dec)	0.2

Reservoir/Fluid Parameters

Reservoir Pressure (psia)	2965
Reservoir Temperature (°F)	220
Solution GOR (scf/bbl)	768

Oil API 40.7

Separator Gas Gravity 0.855

Bubble Point Pressure (psia) 2741.7

Update PVT Properties

Solution GOR

Bo

Viscosity

Oil Compressibility Correlation

☒ Vasquez & Beggs - 1980

☐ Petrovsky & Farshad - 1993

Dead Oil Viscosity Correlation

☒ Beggs & Robinson - 1975

☐ Glase - 1980

Live Oil Viscosity Correlation

☐ Chew & Connally - 1959

☒ Beggs & Robinson - 1975

Pb/Bo Correlation

☐ Standing - 1947

☐ Glase - 1980

☒ Vasquez & Beggs - 1980

☐ Al-Marhoun - 1988

☐ Dokla & Osman - 1992

☐ Macary & El-Batanony - 1992

☐ Omar & Todd - 1993

☐ Petrovsky & Farshad - 1993

☐ Kartatmodjo & Schmidt - 1994

☐ Almeida - 1997

☐ Al-Shammasi - 2001

☐ AVERAGE ALL CORRELATIONS

Table Parameters

Maximum Pressure (psia) 4000

Minimum Pressure (psia) 500

Capture Screen

Correlation Values

Pressure	GOR	c _g (x10 ⁻⁴)	B _g	μ _o	c _o (x10 ⁻⁴)	B _o	μ _o
4000	768	1.424	1.42	0.378	1.424	1.42	0.378
3685	768	1.545	1.4264	0.365	1.545	1.4264	0.365
3371	768	1.69	1.4336	0.353	1.69	1.4336	0.353
3056	768	1.864	1.4416	0.342	1.864	1.4416	0.342
2742	768	2.077	1.4505	0.332	2.077	1.4505	0.332
2592	718.5	1.4269	0.342	1.4269	0.342	1.4269	0.342
2443	669.6	1.4035	0.354	1.4035	0.354	1.4035	0.354
2293	621.3	1.3804	0.366	1.3804	0.366	1.3804	0.366
2144	573.5	1.3575	0.379	1.3575	0.379	1.3575	0.379
1994	526.4	1.3351	0.393	1.3351	0.393	1.3351	0.393
1845	479.9	1.3129	0.409	1.3129	0.409	1.3129	0.409
1696	434.1	1.2911	0.427	1.2911	0.427	1.2911	0.427
1546	388.1	1.2696	0.447	1.2696	0.447	1.2696	0.447
1397	344.8	1.2484	0.47	1.2484	0.47	1.2484	0.47
1247	301.5	1.2277	0.495	1.2277	0.495	1.2277	0.495
1098	259.1	1.2075	0.525	1.2075	0.525	1.2075	0.525
948	217.8	1.1878	0.559	1.1878	0.559	1.1878	0.559
799	177.7	1.1686	0.6	1.1686	0.6	1.1686	0.6
649	138.9	1.1501	0.649	1.1501	0.649	1.1501	0.649
500	101.8	1.1324	0.708	1.1324	0.708	1.1324	0.708

Tune Oil Properties

Save Simulator Deck

Return

Exit Program Load PE Tools Model Load PE Tools Components Import BIC's Recombination Export CCE Data Export DLE Data Export Adj PVT Data EOS VPT Report Save to PE Tools dBase Info

Oilfield Open PE dB

Constant Composition Expansion

Pressure	Rel Volume	Compressibility
5000	0.9535	1.04e-5
4734	0.9575	1.586e-5
4468	0.9618	1.67e-5
4202	0.9663	1.763e-5
3936	0.9711	1.865e-5
3670	0.9762	1.977e-5
3404	0.9817	2.102e-5
3138	0.9876	2.243e-5
2872	0.9939	2.401e-5
2604	0.9992	2.579e-5
2349	0.9996	2.699e-5
2094	1.0019	-
1834	1.0038	-
1574	1.0098	-
1314	1.0074	-
1054	1.0116	-
794	1.2406	-
534	1.3683	-
274	1.5606	-
14	1.8713	-
4	2.4526	-
0	3.6744	-
0	8.1332	-

Differential Liberation Expansion

Pressure	GOR [1]	Bo [2]	Oil Gravity	Gas Z-factor	Gas Gravity
2834	766.7	1.493	0.701	0.8262	0.797
2564	680.9	1.45	0.712	0.828	0.793
2294	609.6	1.415	0.722	0.8325	0.791
1884	542.6	1.381	0.733	0.835	0.791
1644	479.7	1.349	0.743	0.8396	0.793
1404	418.9	1.318	0.753	0.8493	0.798
1164	361.2	1.288	0.763	0.8615	0.81
924	305.4	1.259	0.774	0.8761	0.83
684	250.8	1.229	0.785	0.8933	0.867
444	194.6	1.198	0.797	0.9132	0.942
204	128.7	1.157	0.812	0.9385	1.135
15	0	1.05	0.842	0.9674	1.899

Gravity of residual oil 36.5 API

[1] Volume of gas at standard pressure and standard temperature per residual volume of oil at standard temperature (scf/bbl or scm/m³)

[2] Volume of oil at indicated pressure and temperature per volume of residual oil at standard temperature

Separator Fluid

Component	Oil (mole%)	Gas (mole%)
CO ₂	0.23	1.59
N ₂	0.01	0.31
C ₁	3.25	69.56
C ₂	3.34	15.98
C ₃	5.62	8.28
nC ₄	1.8	1.08
iC ₄	5.64	2.23
iC ₅	2.49	0.39
nC ₅	2.54	0.28
C ₆	8.38	0.3
C ₇₊	66.71	0

Stock Tank Fluid

Component	Oil (mole%)	Gas (mole%)
CO ₂	0.03	1.62
N ₂	0	0.05
C ₁	0.12	24.49
C ₂	0.55	22.3
C ₃	2.41	27.39
nC ₄	1.27	5.42
iC ₄	4.61	12.59
iC ₅	2.49	0.39
nC ₅	2.65	1.82
C ₆	9.34	1.83
C ₇₊	76.53	0

Fluid Components

CO₂ - mol% .91

N₂ - mol% .16

C₁ - mol% 36.47

C₂ - mol% 9.95

C₃ - mol% 6.97

nC₄ - mol% 1.44

iC₄ - mol% 3.93

iC₅ - mol% 1.44

nC₅ - mol% 1.41

C₆ - mol% 4.33

C₇₊ - mol% 33.29

Σ Comps 100

C₇₊ MW 218

C₇₊ SG .8515

Res Temperature 220 °F

Max Pressure for CCE Table 5000

Save Comps to PE Tools dBase

Run PE EOS

Run SRK EOS

Plp 2612 psi

Match Plp 2634 psi

Final Plp 2634 psi

Factor 1.022319

Tune EOS

Thermal Expansion Factor 1.07626

Run Sep Test

Sep. Press 150 psi

Sep. Temp 75 °F

Pressure 150

Temperature 75

GOR [1] 564

Oil API 40.3

Bo [2] 1.3939

Gas Gravity 1.332

[1] Volume of gas at standard pressure and standard temperature per stock tank volume of oil at standard temperature (scf/bbl or scm/m³)

[2] Volume of saturated oil at bubble point pressure (tuned) and reservoir temperature per volume of stock tank oil at standard temperature

Exit Program Load PE Tools Model Export Simulation to CSV Export Deterministic Results to CSV Save Model to PE Tools dBase Info

Oilfield Run M-C Simulation Open PE dBase

Gas Model

Oil Model

Probabilistic Parameters

Reservoir Area, A 27000 31000 33000 acres

Gross Pay, h 20 30 40 ft

Net-to-Gross, NTG 0.45 0.6 0.75 <dec>

Porosity, phi 13.8 16.5 19.2 %

Initial Water Saturation, Sw 22 28 34 %

Initial Reservoir Pressure, P_i 3400 3600 3800 psi

Abandonment Pressure, P_{ab} 1000 750 500 psi

Reservoir Temperature, T_R 175 175 175 °F

Gas Gravity, G 0.6 0.65 0.7 <dec>

Condensate-Gas Ratio, C_{gr} 10 15 20 bbl/mmscf

Gas Expansion Factor, 1/Bg 208 223.2 238.1 scf/ft³

Recovery Factor, RF 71.1 79.9 87.6 %

Seed (Random-1) 123456

M-C Simulations 10000

Input Distribution

☒ Normal

☐ Triangular

☐ Normal

☐ Triangular

☐ Normal

☐ Triangular

☐ Normal

☐ Triangular

☐ Normal

☐ Triangular

☐ Normal

☐ Triangular

☐ Normal

☐ Triangular

Deterministic Results

Prob	Area	Pay	NTG	Poro	Sw	1/Bg	CGR	RF
P1	37671.2	25.1	0.91	16.5	22.3	229.8	15.4	78.2
P10	34514.2	32.8	0.52	18.6	18.7	225.1	16.1	86.2
P50	36490.6	32.7	0.66	17.6	33.3	224.9	12.7	91
P90	29031.4	23.5	0.6	15.5	30	222.1	15.3	88.9
P99	29953.7	28.2	0.38	14.7	35.3	225.1	13.4	79.3
EV	30948.2	30.1	0.6	16.5	28	223.2	15	79.8

Monte Carlo Gas Volumetric Results

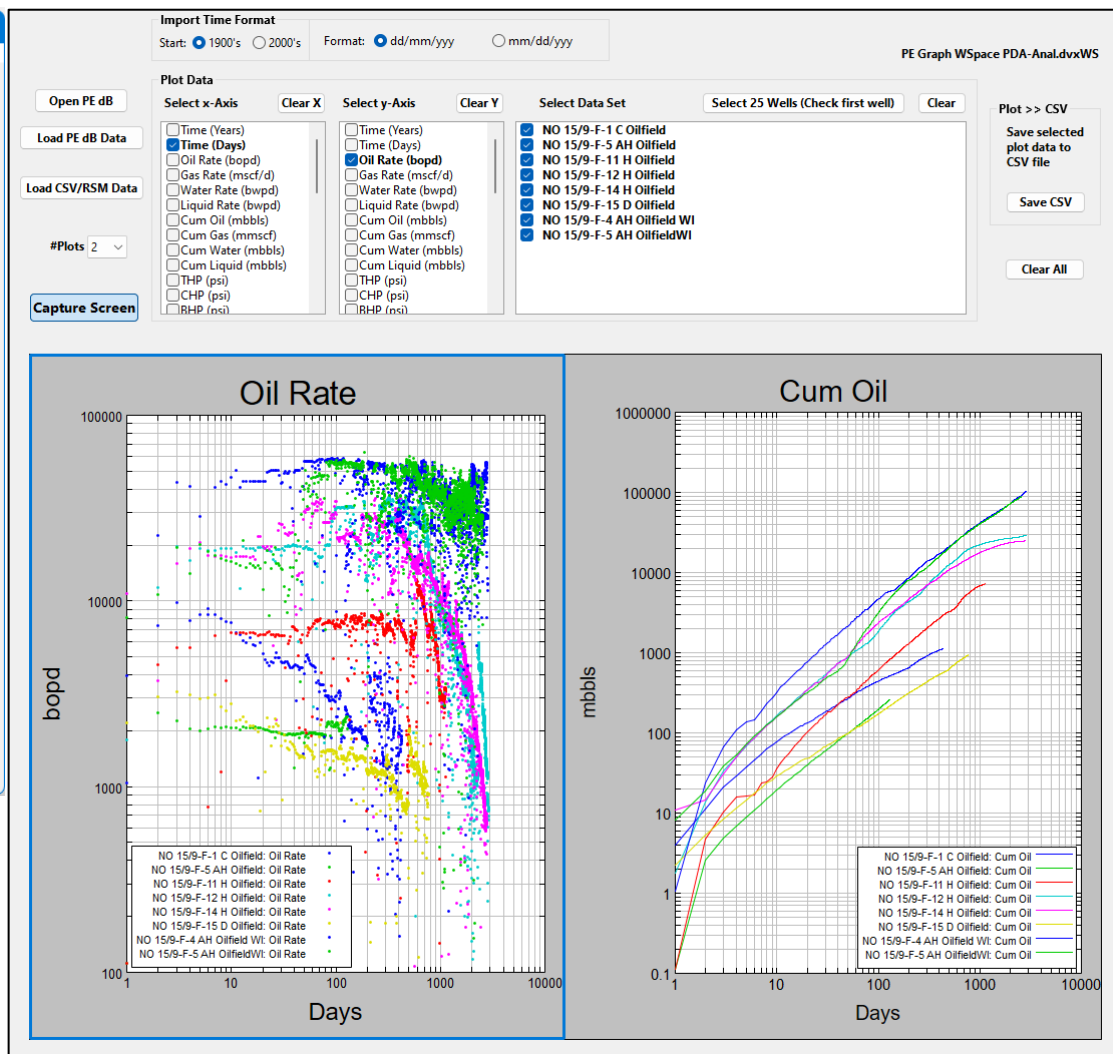
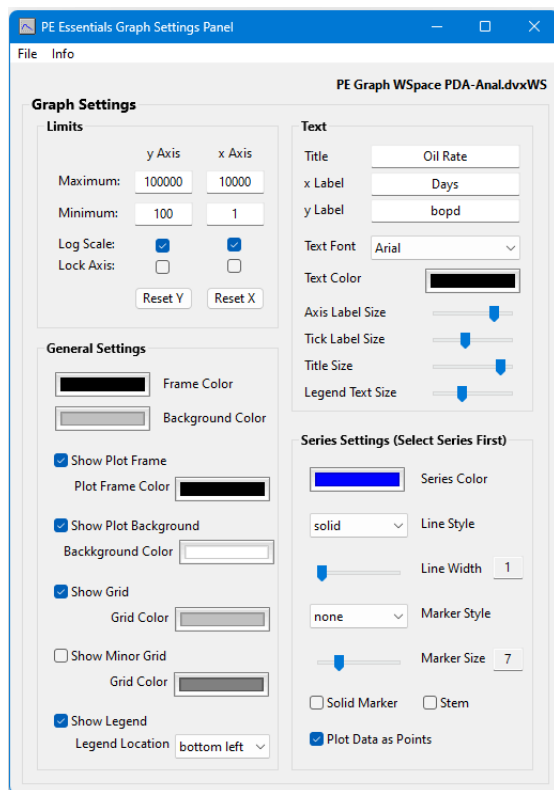
	P90	P50	P10	EV
GIIP	428.38	629.79	881.86	644.47
RGIP	336.92	501.17	709.03	514.44

Cummulative Probability Plot - GIIP and RGIP (Bcrf)

Reservoir Area Distribution

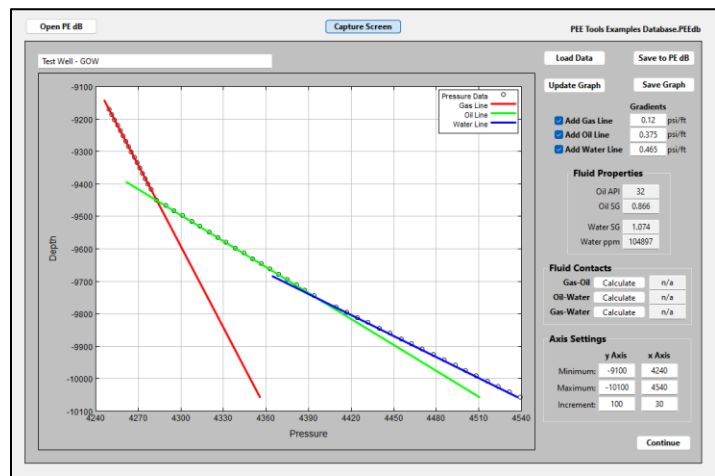
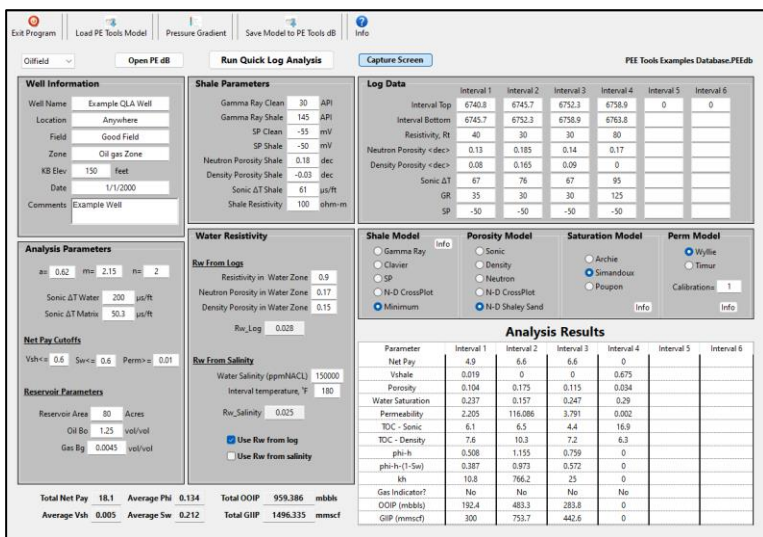
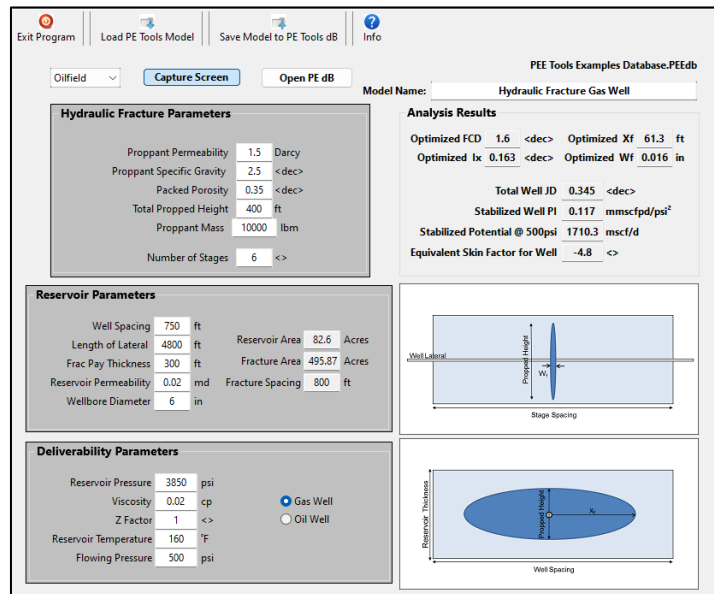
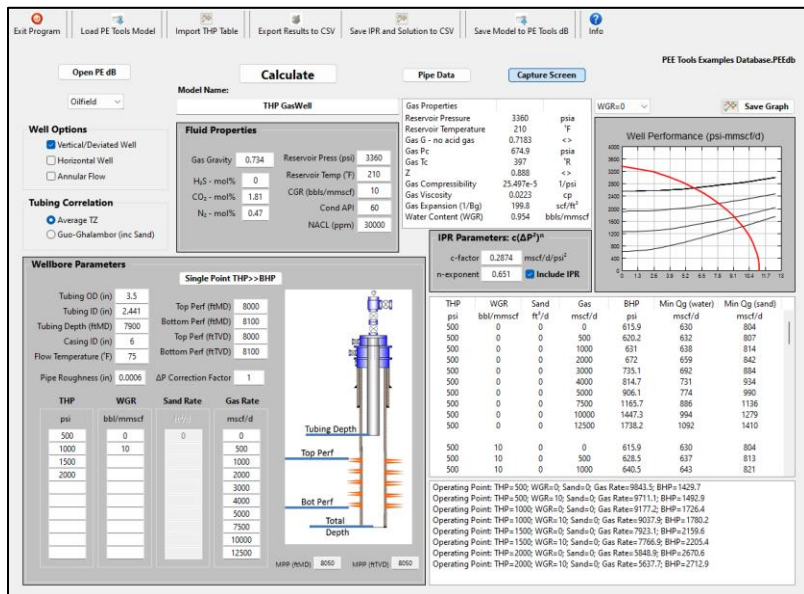
Area 20954.8 30938.3 34918.2

- PE Graph



PE Essentials Tools db - General Data Export Eagle Form Example Row.csv														
PE Essentials Tools db - General Data Export														
Eagle Form Example														
Time	Days	Hours	Gas Date	Gas Date	Water	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil	Oil
Days	Hours	Days	Hours	Days	Hours	Days	Hours	Days	Hours	Days	Hours	Days	Hours	Days
0.00073797	1	42.00095	1119.108	554.5942	507.9307	0.043	1.12	0.055	8.096	0.3857				
5.0000476	1	55.50036	1419.063	537.9051	501.5829	8.000038	2.311	1.903	1.10959	0.4873				
0.0001021	3	58.00096	1068.999	429.4998	488.9998	0.15599	4.4	1.523	1.67959	0.4379				
0.0002959	4	73.99997	1068.999	429.4998	488.9998	0.15599	4.4	1.523	1.67959	0.4379				
0.0156986	5	72.99997	1033.999	291.9999	364.9999	0.26205	7.68	2.156	2.45859	0.4389				
0.0104384	6	92.99996	1224.999	246.9999	309.9999	0.29599	10.135	2.307	2.74259	0.4389				
0.0102178	7	92.99996	1281.999	246.9999	309.9999	0.44849	12.337	2.683	3.08759	0.4389				
0.0219718	8	44.99998	1330.999	130	155	0.52999	13.668	2.713	3.24959	0.4225				
0.0102178	9	91.99996	1281.999	246.9999	309.9999	0.44849	12.337	2.683	3.08759	0.4389				
0.0273973	10	188	2462.999	138.9999	239.9999	0.72899	18.631	3.065	3.78359	0.4215				
0.030317	11	139.9999	2984.999	161.9999	380.9998	0.88998	21.130	3.227	4.00959	0.4269				
0.030317	12	88.99998	2984.999	161.9999	380.9998	0.88998	21.130	3.227	4.00959	0.4269				
0.0301641	13	34.99999	89.9999	51.99999	85.79997	0.10549	24.043	3.4277	4.46239	0.4217				
0.0301641	14	53.99998	1249.999	130	155	0.10549	25.960	3.5087	4.46239	0.4217				
0.0419959	15	0	0	0	0	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	16	0	0	0	0	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	17	0	0	0	0	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	18	0	0	0	0	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	19	0	0	0	0	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	20	68.99997	1068.999	55.99998	118.9999	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	21	58.99998	1249.999	53.99998	114	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	22	127.9999	2984.999	138.9999	247.9999	0.10549	25.960	3.5087	4.46239	0.4217				
0.0404939	23	127.9999	2984.999	138.9999	247.9999	0.10549	25.960	3.5087	4.46239	0.4217				

- Basic THP-BHP Tubing Pressure Drop Calculations for a Gas Well with IPR
- Hydraulic Fracture Design
- Quick Log Analysis – Includes GIIP/OOIP Estimate and Pressure-Depth analysis



• Artificial Lift Design: Rod Pump, Plunger Lift, Jet Pump, ESP

Exit Program Load PE Tools Model Save Model to PE Tools dB Info

Oilfield Open PE dB Capture Screen PEE Tools Examples Database.PEEdb

General Design Parameters

Model Name: Artificial Lift

Reservoir Pressure (psi) 4350 *

Reservoir Temp (°F) 200 *

Oil API 32 *

Bubble Pt Pressure (psi) 500 *

Gas Gravity 0.6 *

Salinity (ppm NaCl) 35000 *

Solution GOR (scf/bbl) 54.5

Oil Bo 1.089

Water Bw 1.032

Surface Producing Conditions

Producing GLR (scf/bbl) 87

Producing Water Cut (%) 25

Design Liquid Rate (bbl/d) 10

Flowing Pressure (psi) 25 *

Flowing Temperature (°F) 100

* Required data for selected pump

Sucker Rod Pump Design Parameters

Tubing OD (in) 3.5

Tubing ID (in) 2.992

Plunger Diameter (in) 2.25

Rod Diameter (in) .875

Crank-to-Pitman Ratio 3246

API Pump Dimension A (in) 111

API Pump Dimension C (in) 96.05

API Pump Dimension R (in) 37

Max Allowable Accel Factor 256

Pump Setting Depth (ftMD) 3500

Annulus Liquid Depth (ftMD) 3500

Tubing Anchored? ☒ Yes ☐ No

Polished Rod Stroke (in) 86

Pumping Speed (spm) 18

Pump Volumetric Efficiency .8

Safety Factor for Prime Power 1.35

Type of Pump ☒ Conventional ☐ Mark II/Balanced

Results

Pumping Liquid Rate (bbl/d) 648.4

Maximum Speed (spm) 138

Resulting Hydraulic Power (hp) 16.5

Maximum PRL (lbs) 15391

Resulting Friction Power (hp) 7

Minimum PRL (lbs) 4503

Required Prime Mover Power (hp) 31.8

Counterweights (lbs) 9947

Exit Program Load PE Tools Model Save Model to PE Tools dB Info

Oilfield Open PE dB Capture Screen PEE Tools Examples Database.PEEdb

General Design Parameters

Model Name: Artificial Lift

Reservoir Pressure (psi) 4350 *

Reservoir Temp (°F) 200 *

Oil API 32 *

Bubble Pt Pressure (psi) 1500 *

Gas Gravity 0.6 *

Salinity (ppm NaCl) 35000 *

Solution GOR (scf/bbl) 200.7

Oil Bo 1.157

Water Bw 1.032

Surface Producing Conditions

Producing GLR (scf/bbl) 200 *

Producing Water Cut (%) 95

Design Liquid Rate (bbl/d) 50 *

Flowing Pressure (psi) 100 *

Flowing Temperature (°F) 100 *

* Required data for selected pump

Plunger Lift Design Parameters

Pump Setting Depth (ftMD) 7000

Tubing ID (in) 1.995

Tubing OD (in) 2.375

Casing ID (in) 4.56

Maximum Available CHP (psi) 800

Selected Pump Information

Selected Plunger Weight (lbs) 10

Plunger Fall Velocity in Gas (ft/min) 750

Plunger Fall Velocity in liquid (ft/min) 150

Plunger Rising Velocity (ft/min) 1000

Results

Plunger Lift Will Operate with Slugs Between n/a and n/a bbls

Slug Vol (bbl)	CHP-min (psi)	CHP-max (psi)	N-max (cycle/d)	Qliq-max (bbl/d)	GLR-min (scf/bbl)	N (cycle/d)	Fall Time (min)
0.1	127	186	87	8.7	37688	-	10
0.25	138	201	85	21.1	16297	-	10
0.5	155	227	81	40.3	9163	-	11
1	190	278	75	74.2	5589	50	12
2	260	380	65	128.2	3789	25	15
3	330	482	57	169.2	3176	17	19
4	400	585	51	201.4	2859	13	22
5	470	687	46	227.4	2661	10	25
6	540	789	42	248.8	2521	9	28
8	679	993	36	281.9	2328	7	34
10	819	1198	31	306.4	2191	5	40

Exit Program Load PE Tools Model Save Model to PE Tools dB Info

Oilfield Open PE dB Capture Screen PEE Tools Examples Database.PEEdb

General Design Parameters

Model Name: Artificial Lift

Reservoir Pressure (psi) 4350 *

Reservoir Temp (°F) 200 *

Oil API 32 *

Bubble Pt Pressure (psi) 1500 *

Gas Gravity 0.6 *

Salinity (ppm NaCl) 35000 *

Solution GOR (scf/bbl) 200.7

Oil Bo 1.157

Water Bw 1.032

Surface Producing Conditions

Producing GLR (scf/bbl) 200 *

Producing Water Cut (%) 10 *

Design Liquid Rate (bbl/d) 500 *

Flowing Pressure (psi) 100 *

Flowing Temperature (°F) 100 *

* Required data for selected pump

Jet Pump Design Parameters

Reservoir Depth (ftMD) 10000

Pump Setting Depth (ftMD) 9700

Max Rate for Vogel IPR (stb/d) 8000

Tubing ID (in) 1.992

Tubing OD (in) 2.375

Casing ID (in) 5

Selected Pump Information

Selected Pump Area Ratio, R-value 0.262

Selected Pump Jet Nozzle Area (in²) 0.16

Selected Pump Peak Efficiency 0.255

Dimensionless Rate at Peak Efficiency 0.9

Power Fluid Specific Gravity 0.8

Results

Required Pump Discharge Pressure Based on CHP (psi) 2993

Required Pressure at Pump Inlet Pressure (psi) 4091

Flowing Bottom Hole Pressure (psi) 4197

Pump Outlet Pressure (psi) 4084

Pump Intake Pressure (psi) 4082

Required Pump Power (hp) 9.8

Power Fluid Rate (bbl/d) 636

Pumping Flowing CHP (psi) 719

Total Return Rate (bbl/d) 1208

Surface Operating THP (psi) 909

Exit Program Load PE Tools Model Save Model to PE Tools dB Info

Oilfield Open PE dB Capture Screen PEE Tools Examples Database.PEEdb

General Design Parameters

Model Name: Artificial Lift

Reservoir Pressure (psi) 4350 *

Reservoir Temp (°F) 200 *

Oil API 32 *

Bubble Pt Pressure (psi) 1500 *

Gas Gravity 0.6 *

Salinity (ppm NaCl) 35000 *

Solution GOR (scf/bbl) 200.7

Oil Bo 1.157

Water Bw 1.032

Surface Producing Conditions

Producing GLR (scf/bbl) 200 *

Producing Water Cut (%) 90 *

Design Liquid Rate (bbl/d) 8000 *

Flowing Pressure (psi) 100 *

Flowing Temperature (°F) 100 *

* Required data for selected pump

ESP Design Parameters

Reservoir Depth (ftMD) 10000

Pump Setting Depth (ftMD) 9800

Max Rate for Vogel IPR (stb/d) 15000

Tubing ID (in) 2.992

Min Pump Suction Pressure (psi) 200

Min Capacity of Pump (bbl/d) 10000

Pumping Head per Stage (ft/stage) 60

Power per Stage (hp) 6

Results

Required Pump Discharge Pressure Based on THP (psi) 4775

Flowing Bottom Hole Pressure (psi) 2823

Production Rate at Pump (bbl/d) 8358

Minimum Pump Setting Depth (ft) 3997

Pump Suction Pressure (psi) 2735

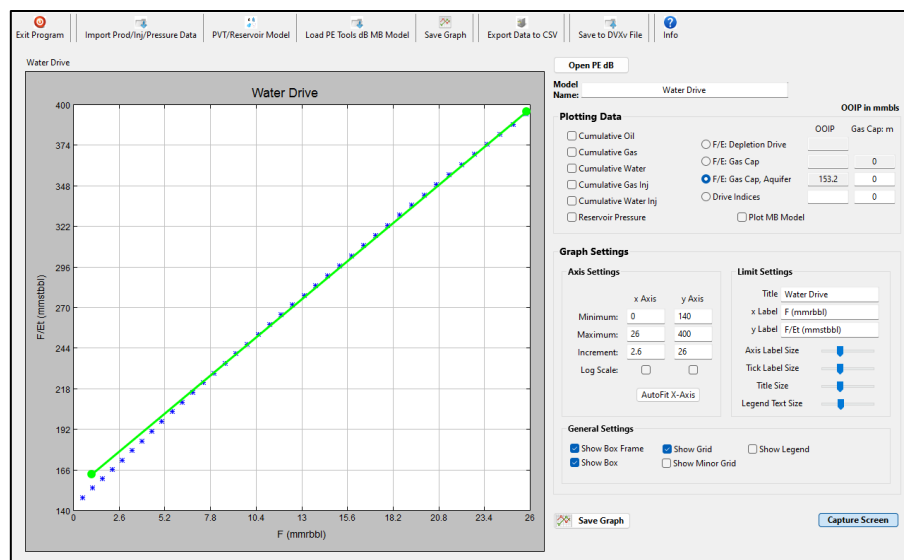
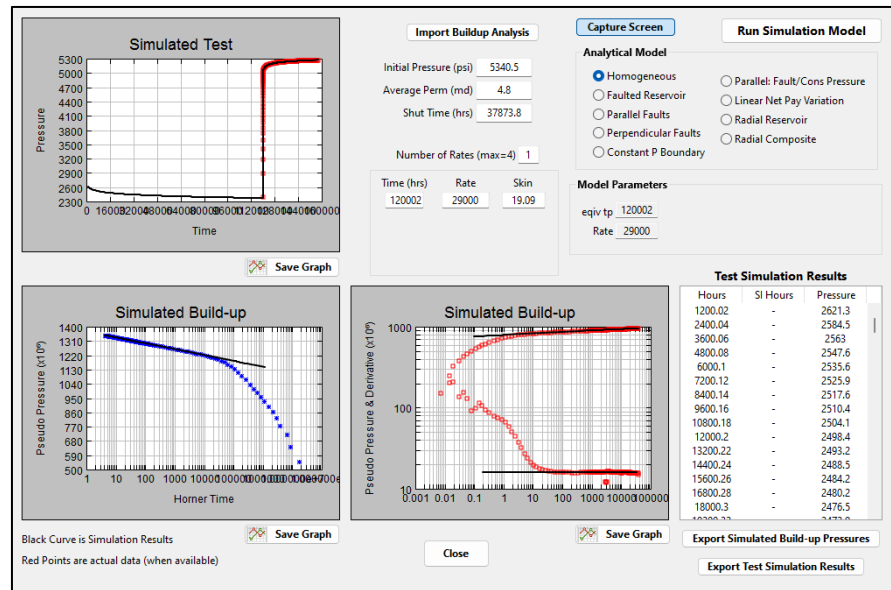
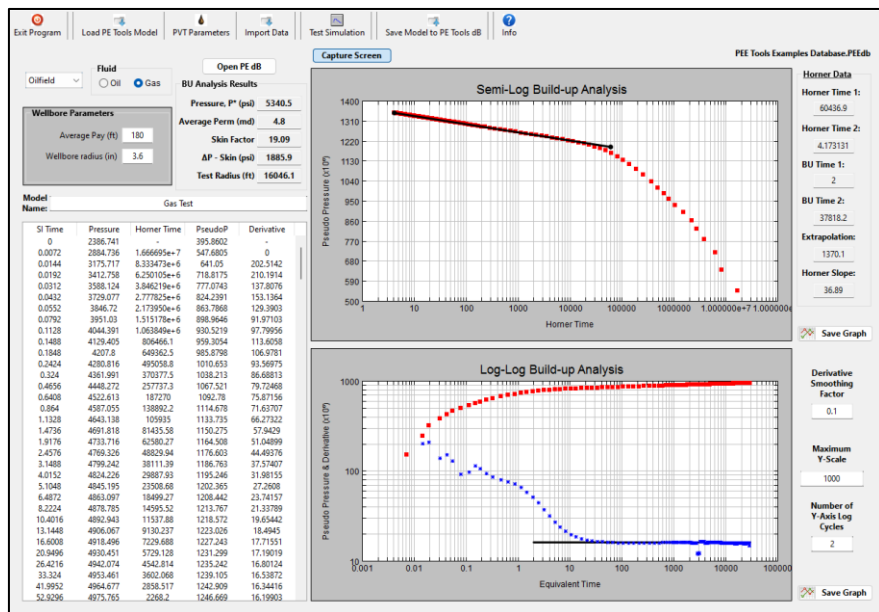
Required Pump AP (psi) 2040

Required Pumping Head (ft) 4711

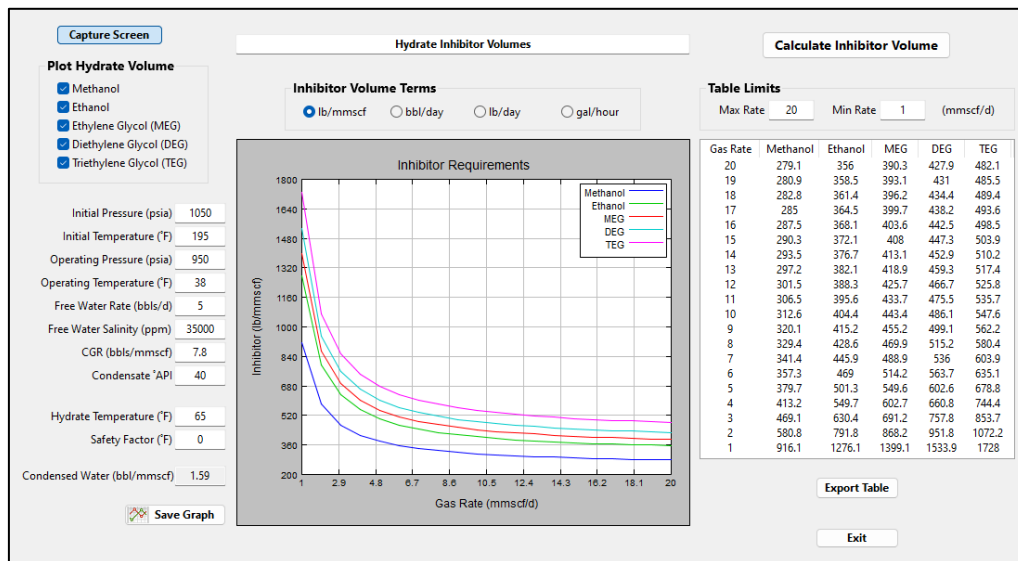
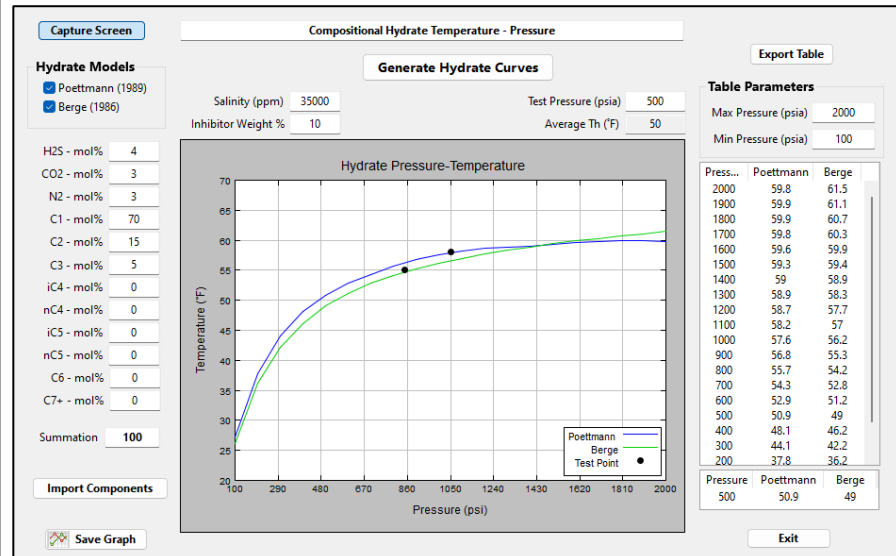
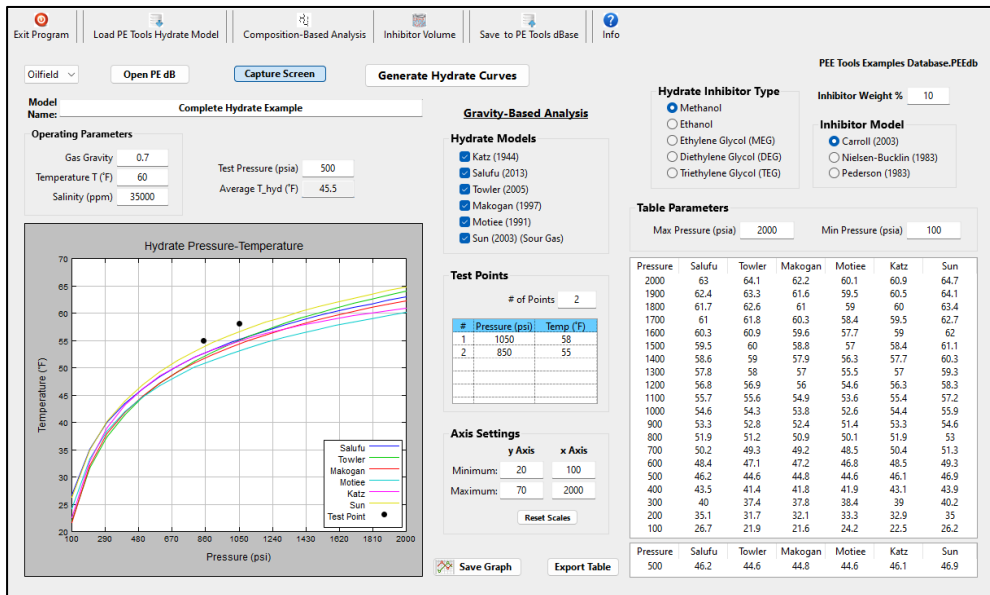
Required Number of Stages 79

Total Motor Power (hp) 471.1

- Pressure Transient Analysis and Analytical Well Test Simulator
- Volumetric Surveillance and Material Balance Analysis



- Hydrate Analysis – includes inhibitor volume forecast



- Horizontal Hydraulically Fractured Well Forecasting (includes a History Matching tool)
- Basic Reservoir Simulator – General Purpose Reservoir Simulator (exports simulator data file)
- Streamline WaterFlood Simulator (Leighton and Higgins streamline simulator)
- Miscible/Immiscible CO₂, WAG and Waterflood Streamline Simulator (DOE Model)

Exit Program Load PE Tools Model PVT Reservoir Frac Wellbore Plot Economics Export Results to CSV Save Forecast to PE Tools dB Save Model to PE Tools dB Info

Oilfield Model Name: Unconventional Gas Capture Screen Generate Forecast PEE Tools Examples Database.PEEdb

Open PE dB Gas Model Analytical Model Perform History Match

Run Parameters

Maximum Gas Rate (mcsf/d)	10000
Minimum Gas Rate (mcsf/d)	50
Flowing Wellhead Temperature (F)	50
Flowing Tubing Head Pressure (psi)	800

2Fracs

Days	Rate mcsf/d	Cum mmscf	ResPress psi	THP psi
0	10000	0	3850	2190.3
0.1	10000	0.9	3850	2049.1
0.2	10000	1.9	3849.6	1844.7
0.3	10000	2.9	3849.1	1728.3
0.4	10000	3.9	3848.7	1639.5
0.5	10000	4.9	3848.2	1557.8
0.6	10000	5.9	3847.7	1479.2
0.7	10000	6.9	3847.3	1399.6
0.8	10000	7.9	3846.8	1317.6
0.9	10000	8.9	3846.4	1235
1	10000	9.9	3845.9	1147.2
1.1	10000	10.9	3845.4	1053.8
1.2	10000	11.9	3845	954.7
1.3	10000	12.9	3844.5	844.4

Month Well IP

Month	Well IP
1 month	3318 mscf/d
3 month	1913 mscf/d
6 month	1299 mscf/d
9 month	1040 mscf/d
12 month	900 mscf/d
24 month	666 mscf/d

3Fracs

Month	Well IP
1 month	4788 mscf/d
3 month	2788 mscf/d
6 month	1886 mscf/d
9 month	1502 mscf/d
12 month	1294 mscf/d
24 month	940 mscf/d

4Fracs

Month	Well IP
1 month	6106 mscf/d

EUR (Bscf) vs #Fracs

Cum Forecast (Bscf)

Exit Program Load PE Tools Model Grid PVT Rel Perm Reservoir Wellbore Schedule Basic Plot Export Results to CSV Save Forecast to PE Tools dB Save Model to PE Tools dB Export to Sim Info

Oilfield Dry Gas Model Open PE dB Run Simulator Capture Screen

Cur Sim Days: 3650 Table Update Frequency (secs): 1 Simulator Options

Run Parameters

Model Name: Gas/Horizontal

Minimum Gas Rate (mcsf) 50

Flowing Wellhead Temperature (F) 50

Minimum Wellbore Pressure (psi) 500

Enter Simulation Time (yrs) 10

Save Simulation Run Data

IGIP OIP WIP

Bscf mmbbls mmbbls

Cum Forecast (mmscf)

Days Sales Gas CumG Cond Water Well PR Pwf THP RF Iters max dP Well Sw Well Sg Well So mbe_gas FieldPR

Days	Sales Gas	CumG	Cond	Water	Well PR	Pwf	THP	RF	Iters	max dP	Well Sw	Well Sg	Well So	mbe_gas	FieldPR
0.0723665	1428.6	0.1126374	95.4	0	3282	500	357.8	0.0063	2	-5.1	0.2	0.8	0	0	3825.1
0.1791249	1140.9	0.2488148	76.8	0	2785.3	500	370.5	0.0104	3	-10.4	0.2	0.8	0	0	3817.5
0.3877823	834.5	0.4518031	55.7	0	2269.2	500	382.1	0.0235	3	-4.4	0.2	0.8	0	0	3805.5
0.9934593	508	0.8357568	33.9	0	1742.7	500	388.5	0.0471	4	-7	0.2	0.8	0	0	3787.7
4.559834	336.7	2.175922	22.5	0	1421.9	500	390.8	0.1227	6	-4.2	0.2	0.8	0	0.001	3753.9
59.38277	299.6	19.10954	30	0	1360.7	500	391.2	1.0772	8	-4	0.2	0.8	0	0.005	3675.7
230.1158	274.1	67.78711	18.3	0	1318.5	500	391.5	3.8212	16	-3.2	0.2	0.8	0	0.004	3534.7
541.2925	251.5	149.3024	16.8	0	1274.7	500	391.6	8.4162	37	-8.6	0.2	0.8	0	0.056	3348.8
1051.239	224.1	270.0816	15	0	1219.4	500	391.9	15.2246	34	-7.3	0.2	0.8	0	0.053	3104.3
1636.293	198.9	393.347	13.3	0	1163.7	500	392	22.1731	29	-5.8	0.2	0.8	0	0.061	2882.4
2251.293	178	508.8112	11.9	0	1113.9	500	392.2	28.6818	26	-4.9	0.2	0.8	0	0.051	2685.2
3196.293	153.3	664.7092	10.2	0	1049.4	500	392.3	37.4699	22	-3.8	0.2	0.8	0	0.067	2436
3650	142.7	731.7598	9.5	0	1020.1	500	392.3	41.2495	8	-1	0.2	0.8	0	0.015	2337

Exit Program Load PE Tools Model Export Results to CSV Save Forecast to PE Tools dB Save Model to PE Tools dB Info

Oilfield Open PE dB Model Name: Waterflood Capture Screen PEE Tools Examples Database.PEEdb

Relative Permeability Parameters

Sor	Swi	Res Expn	Res Expn
0.3	0.2	2	2

Waterflood Pattern

5 Spot

Line Drive (1x1)

Staggered Line Drive (3x1)

Seven Spot

Waterflood Parameters

Distance From Injector to Producer 552 ft

Injector - Producer Pressure Drop 500 psi

Constant Injection Rate

Maximum Water Cut 98 %

Waterflood Options

Constant Rate Waterflood

Constant Pressure Waterflood

Reservoir Parameters

Net Pay Thickness (Layer 1)	250	ft
Formation Permeability (Layer 1)	0.5	md
Formation Porosity (Layer 1)	0.08	frac
Reservoir Pressure	3000	psi
Reservoir Temperature	160	F
Wellbore Diameter	8	in
Oil API	30	
Bubble Point Pressure	3000	psi
Gas Gravity	0.7	
Current Gas Saturation, Sgc	0.01	frac
Current Water Saturation, Swc	0.3	frac

Layer Parameters

Gas Viscosity	0.0216	cp
Oil Viscosity	0.9	cp
Water Viscosity	0.44	cp
Bo	1.293	bbbl/stb
Bw	1.02	bbbl/stb

Pattern Area (Acres) = 13.99

Recovery @ 100% WCut (mbbl) = 597.5

OOIP Per Pattern (mbbl) = 1158.379

Forecast WF Recovery Factor (%) = 46.8

Forecast WF Recovery Factor (%) = 40.5

Oil Rate (bopd) vs Year

Water Cut (%) vs Year

Exit Program Load PE Tools Model Export Results to CSV Save Forecast to PE Tools dB Save Model to PE Tools dB Info

Oilfield Open PE dB Capture Screen Run Pattern Waterflood Model Name: CO2 Waterflood PEE Tools Examples Database.PEEdb

Relative Permeability Parameters

Swi	0.2	msd	2	Knw(Sor)	0.3
Sorw	0.37	msd	2	Krw(Swi)	0.4
Sgr	0.37	msd	2	Krg(Swi)	0.4
Sorg	0.37	msd	2	Krg(Swi)	0.4
Sor	0.37	msd	2	Krg(Swi)	0.4
Sor	0.001				

Waterflood Parameters

Distance From Injector to Producer 552 ft

Injector - Producer Pressure Drop 500 psi

Constant Injection Rate

Maximum Water Cut 98 %

Waterflood Options

Constant Rate Waterflood

Constant Pressure Waterflood

Reservoir Parameters

Total Net Pay Thickness	100	ft
Average Permeability	1	md
Average Porosity	0.2	frac
Ratio of (kvw)/khor	0.1	
Current Reservoir Pressure	2000	psi
Reservoir Temperature	105	F
Minimum Miscible Pressure	1200	psi
Bubble Point Pressure	2000	psi
Gas Gravity	0.7	
Water Salinity (NaCl ppm)	100000	
Current Gas Saturation, Sg	0	frac
Current Water Saturation, Sw	0.3	frac
Parameter: Degree of Mixing	0.667	Info
Options: Miscible Phase Rel Perm	0	Info
Bottomhole Injection dP	2000	psi
Injector Well Skin Factor	-6	

Dykstra-Parsons Coefficient

0.7

D-Layer Params

Layer	Thick	Perm
1	20	2.031
2	20	0.952
3	20	0.563
4	20	0.334
5	20	0.149

Waterflood Parameters

Water Viscosity	0.0181	cp
Oil Viscosity	2.41	cp
Water Viscosity	0.78	cp
Gas/Oil Ratio	404.89	scf/bbl
Bo	1.209	bbbl/stb
Bw	1.007	bbbl/stb
Max Water Inj Rate	505.4	bbbl/d
Max Gas Inj Rate	38.3	mmcsf/d

Pattern Area (Acres) = 40

Forecast Recovery Potential (mbbl) = 1747.3

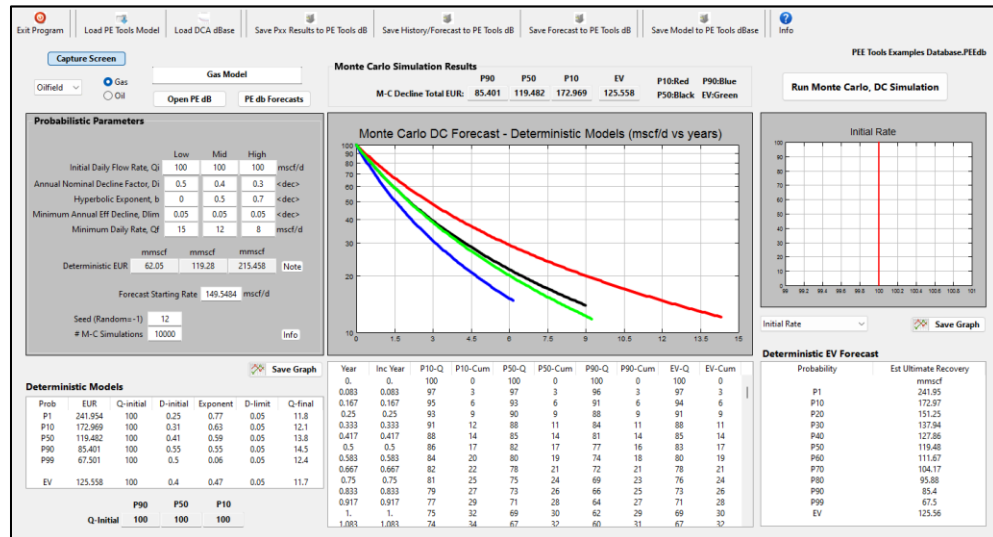
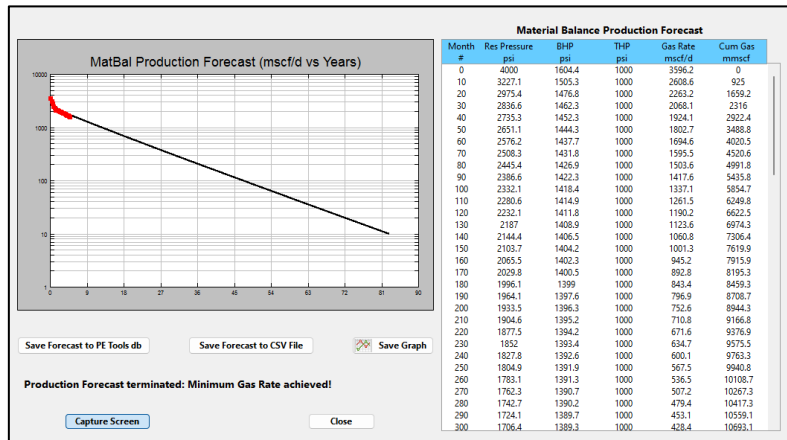
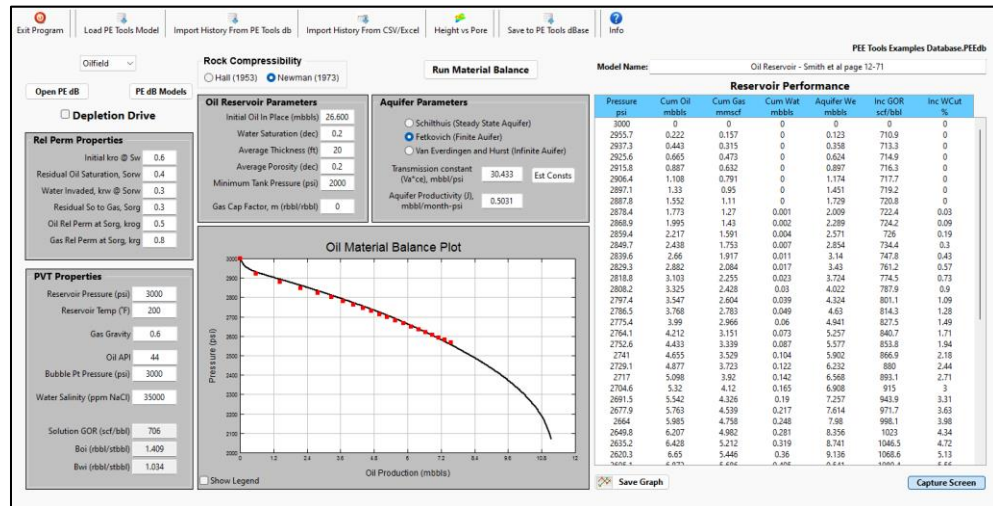
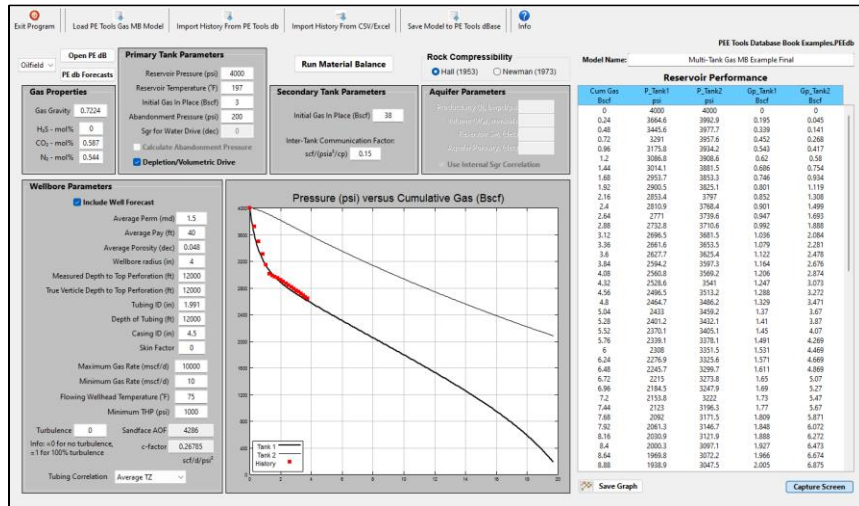
OOIP Per Pattern (mbbl) = 3593.4

Forecast Recovery Factor (%) = 48.6

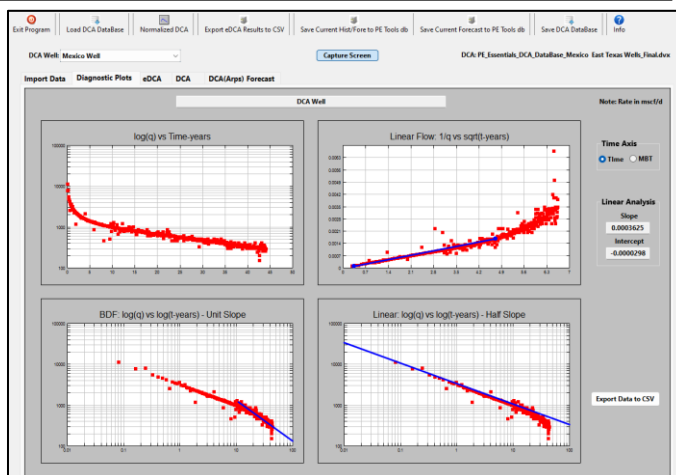
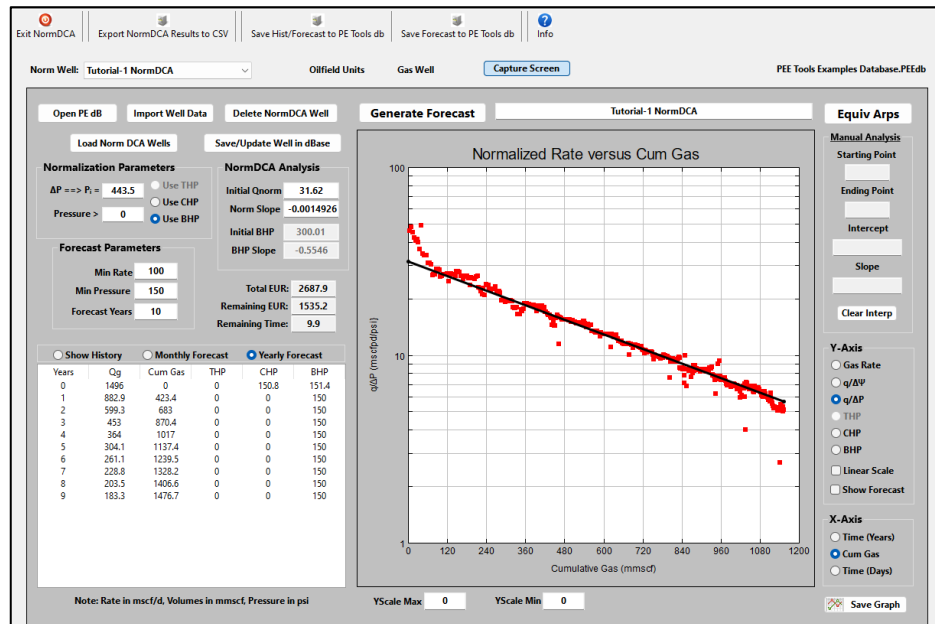
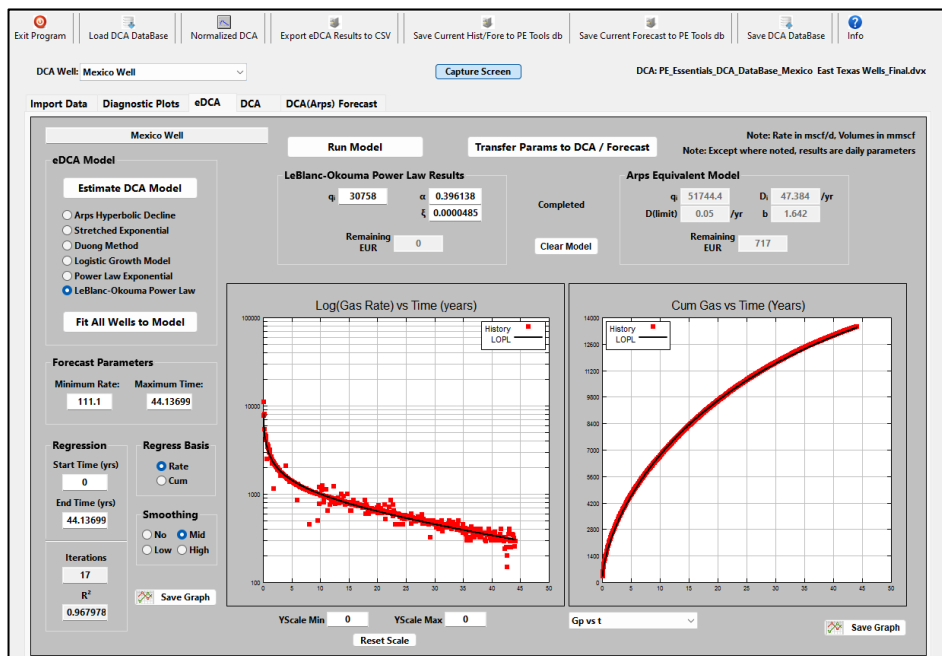
Oil Rate (bopd) vs Year

Water Cut (%) vs Year

- Multi-Tank Gas Material Balance and Gas/Aquifer Material Balance Analysis/Simulator
- Oil Material Balance Analysis/Simulator – 3 aquifer models
- Monte Carlo Decline Curve Production Forecasting (Probabilistic Forecast)

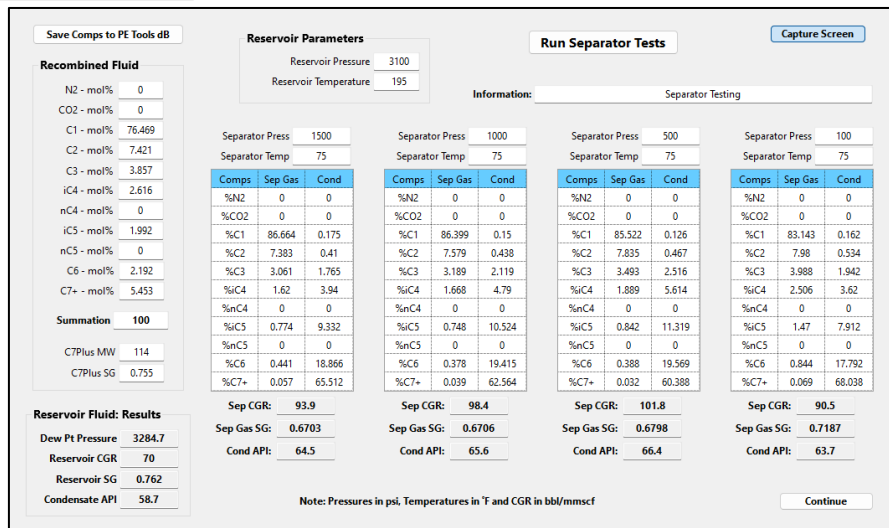
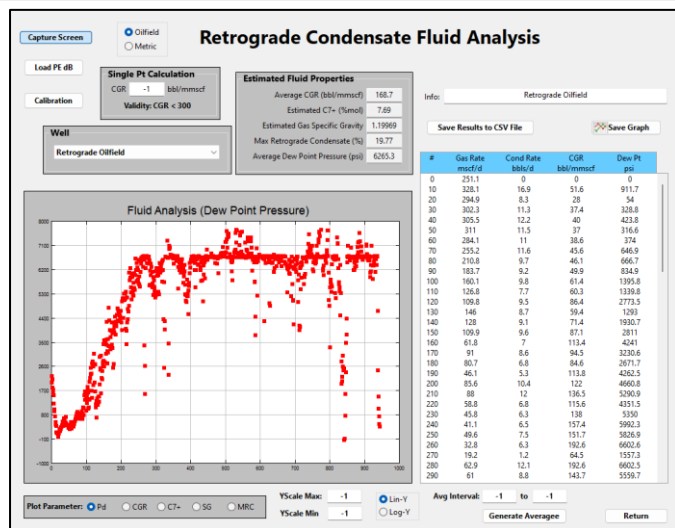
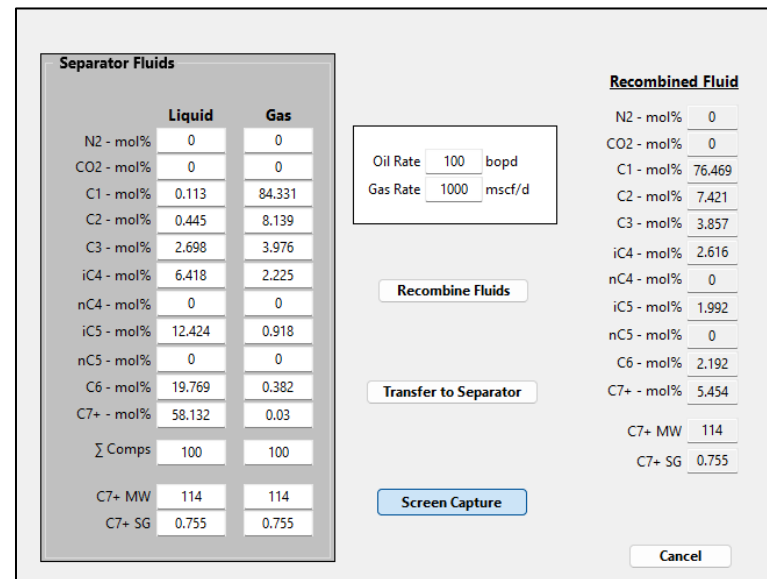
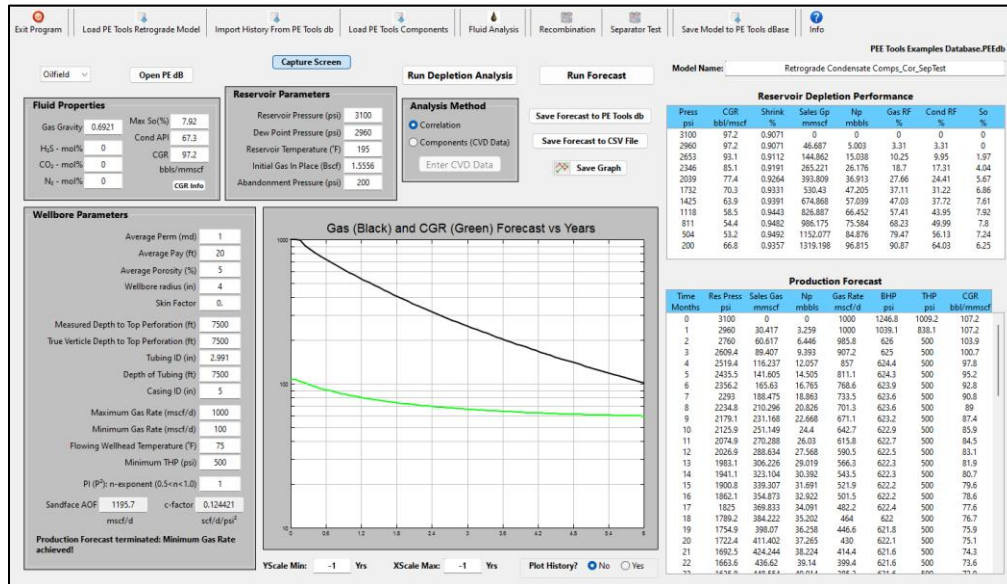


- Decline Curve Analysis and Production Forecast – Includes Diagnostic Plots
- Normalized Decline Curve Analysis and Production Forecast

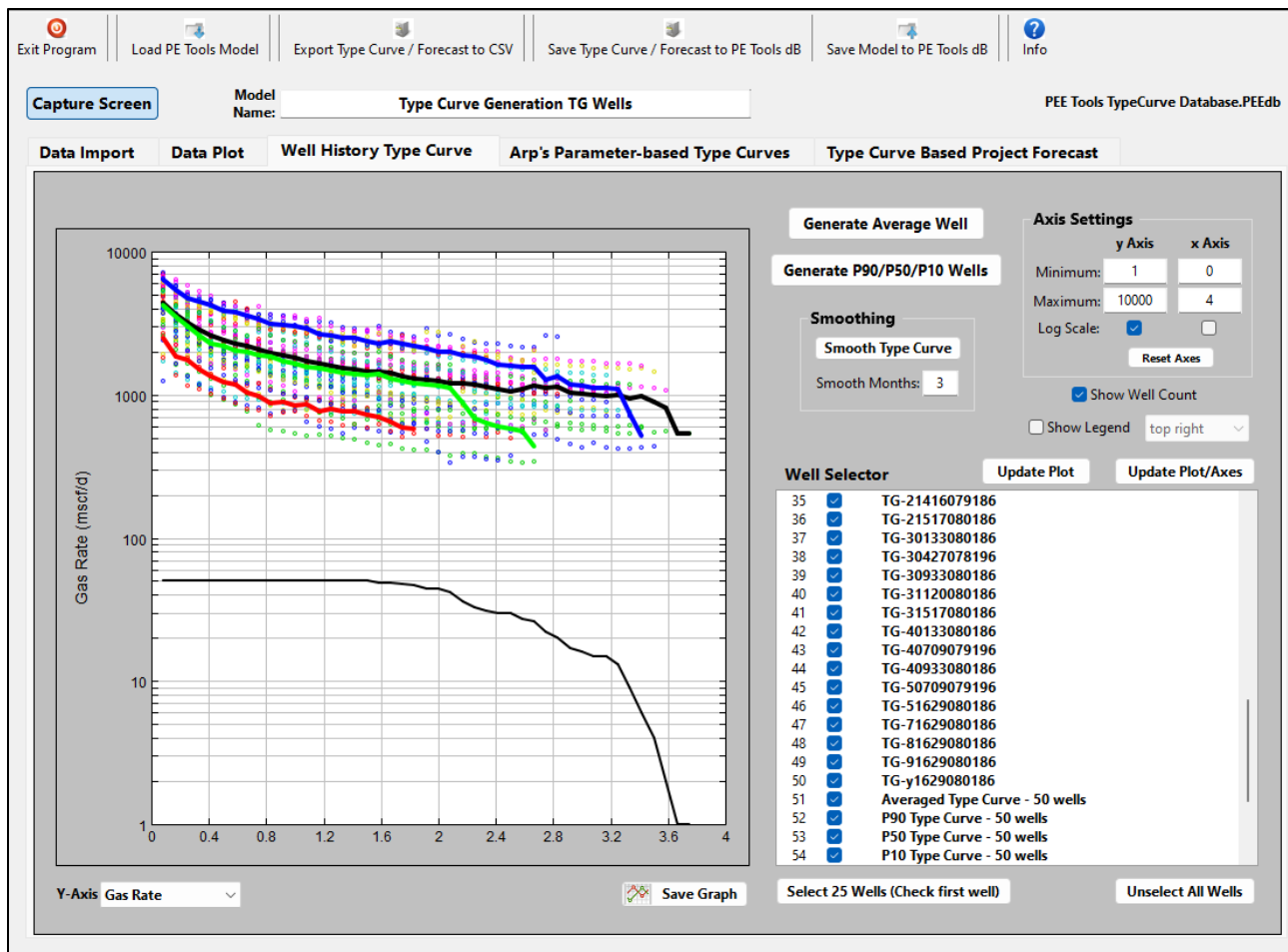


Forecast Essentials

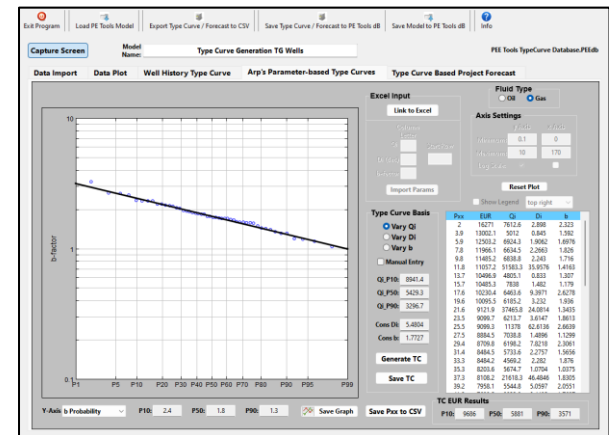
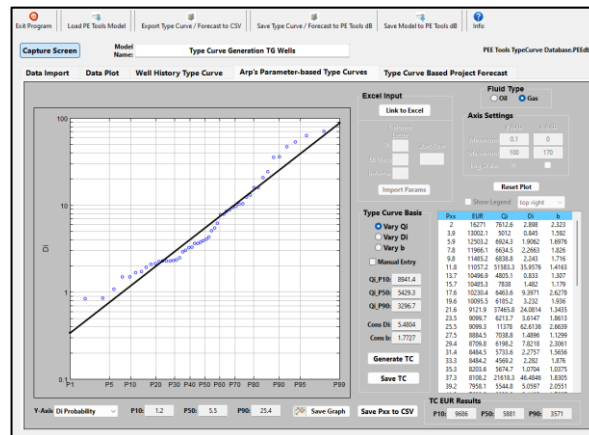
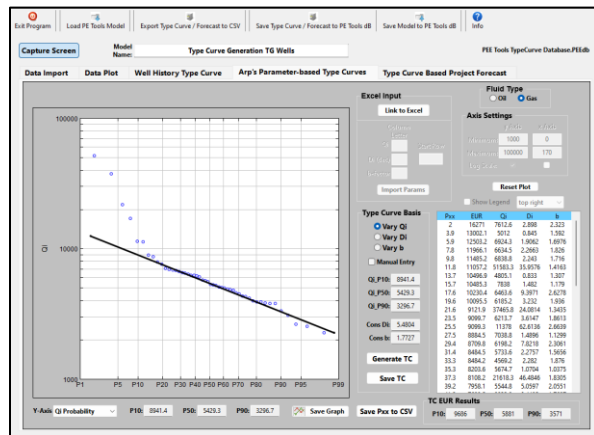
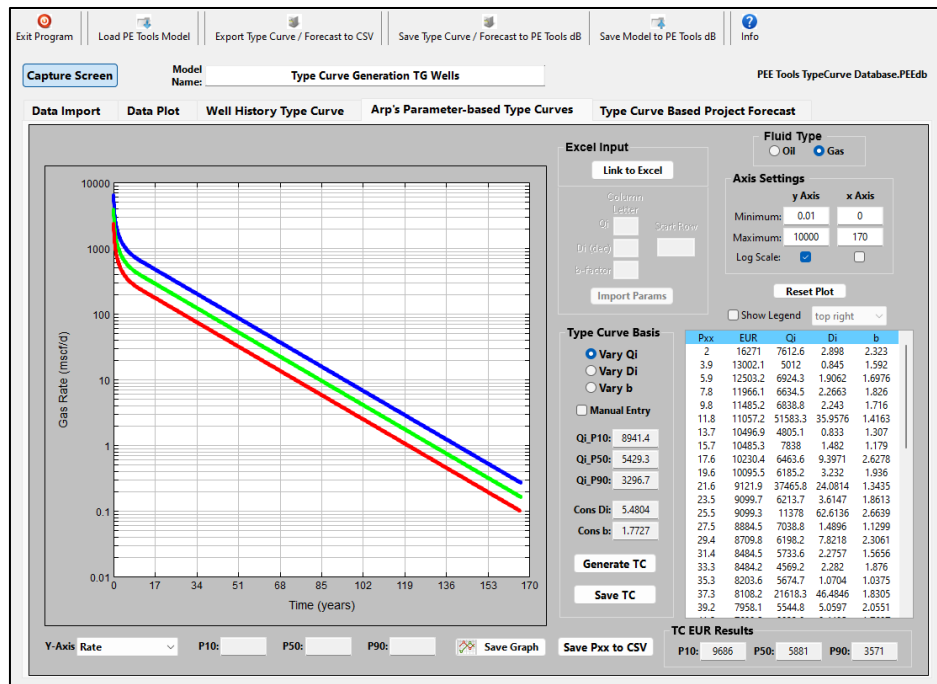
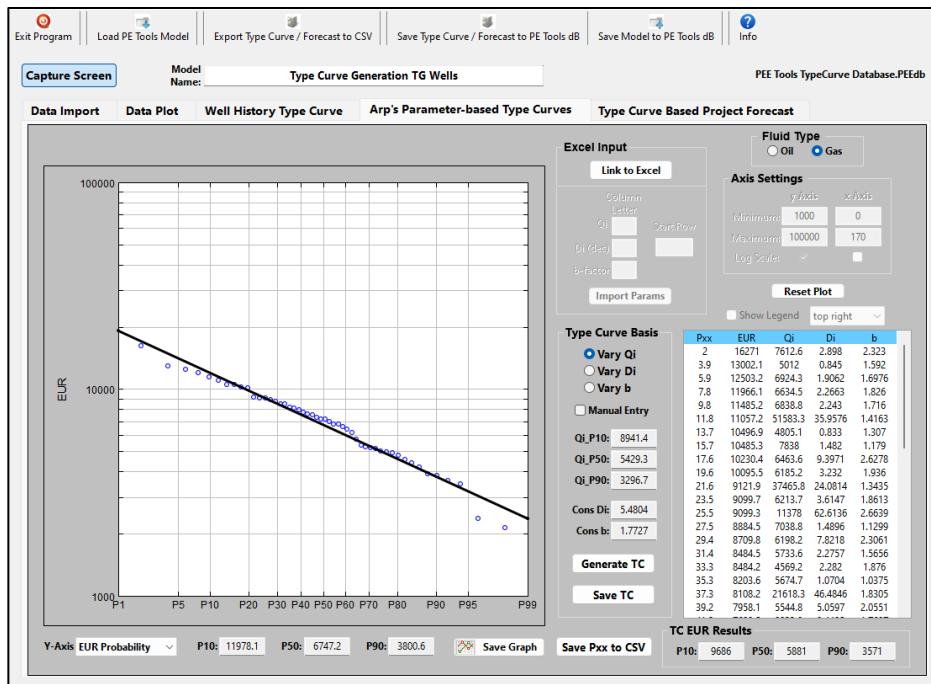
- Retrograde Condensate tool: Includes: Oil/Gas Recombination, Fluid Properties from CVD and Correlations, Separator Tests



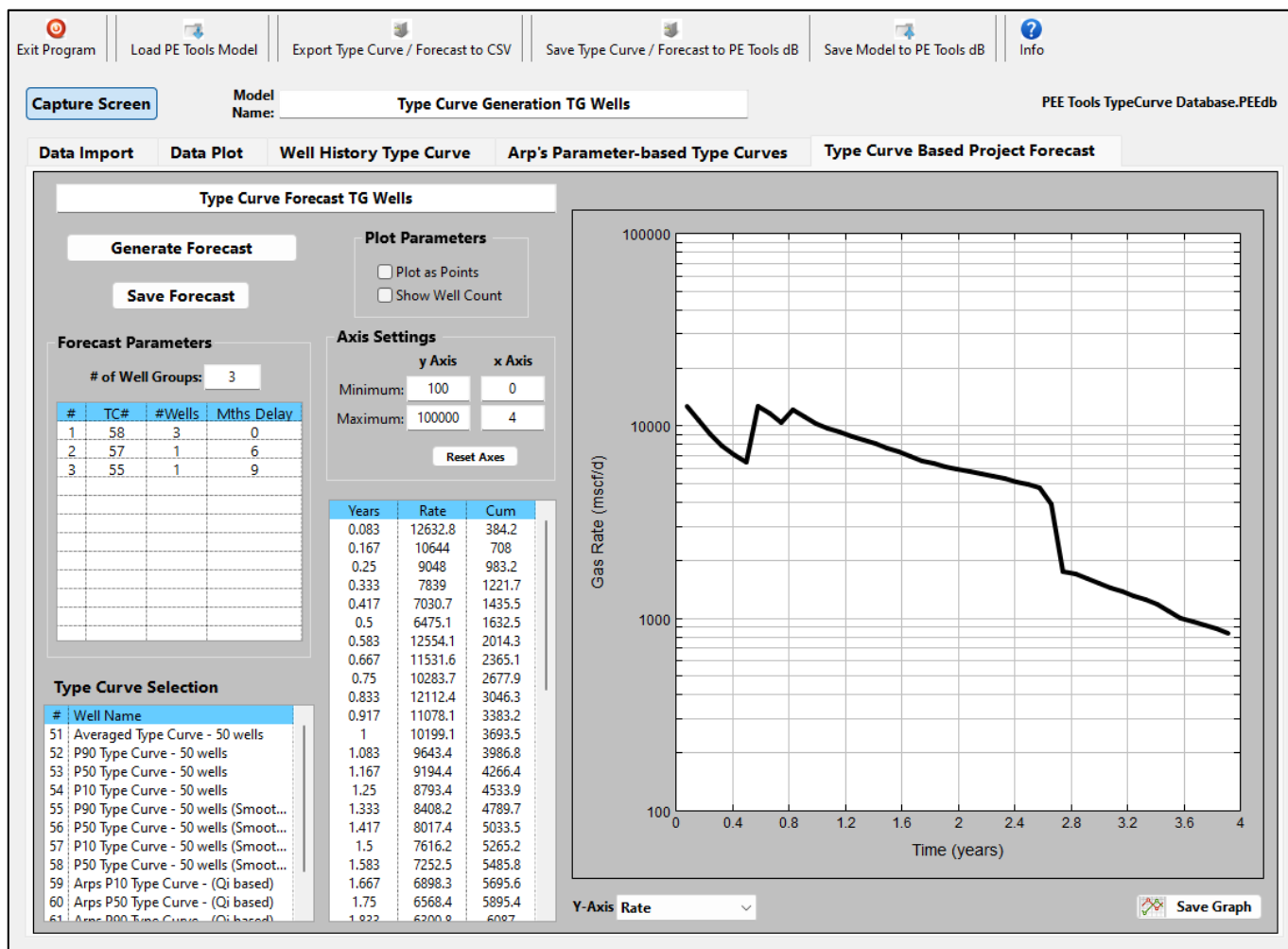
- Type Curve Generation tool includes average and P90/P50/P10 type curve using historical data (1)



- Type Curve Generation tool includes type curve generation using Arps parameters (2)



- Type Curve Generation tool includes multi-well project forecasts generated using the type curves (3)



- IOR/EOR Screening Tool (screens 18 different processes)
- IOR/EOR/Heavy Oil Tools (MMP, Thermal Properties, Hot/Cold Injection, Pump Rates)

Close Screening Tool

Load PE Tools Screening Model

Save Screening Model to PE Tools db

Info

Oilfield

Open PE dB

Capture Screen

Model Name:

IOR_EOR Screening

Fluid Properties

Oil API	30	Reservoir Press (psi)	3000
Gas Gravity	0.8	Current Press (psi)	2000
NACL (ppm)	200000	Reservoir Temp (°F)	160
		Bubble Pt Pressure (psi)	3000
		Water Hardness (ppm)	3000
		Acid number	0

Reservoir Parameters

Average Perm (md)	10
Average Pay (ft)	25
Average Porosity (%)	15
Average Sw (%)	20
Residual Oil Saturation (%)	20
Current WOR (bbl/bbl)	1
Reservoir Depth (ft)	7000
k _v /k Ratio	0.2
Dykstra-Parsons Coefficient	0.75
Min Miscible Pressure (psi)	2000

☒ Sandstone
 ☐ Shaly Sandstone
 ☐ Carbonate

IOR/EOR Screening Criteria

Horizontal Wells	
Depth (ft)	- (1)
Oil Net Pay (ft)	> 10 (2)
Porosity (%)	- (3)
Permeability (md)	k _v > 1 (4)
k _v /k	> 0.1 (5)
Dykstra-Parsons Coef	- (6)
SS or Carb Formation	- (7)
Shaley Formation (Yes/No)	No (8)
WOR (bbl/bbl)	- (9)
Current Pressure (psi)	- (10)
Temperature (°F)	- (11)
Min Miscibility Pressure (psi)	- (12)
Oil Saturation (%)	- (13)
Residual Oil, S _o (%)	- (14)
Oil API	- (15)
Viscosity (cp)	- (16)
k _h /k _o (md/cp)	- (17)
Water Salinity (ppm)	- (18)
Water Hardness (ppm)	- (19)
Acid Number	- (20)

Oil Properties

Initial Reservoir Pressure	3000	psia
Initial Saturation Pressure	3000	psia
Initial Solution GOR	654.1	scf/bbl
Initial Oil Viscosity	0.855	cp
Current Reservoir Pressure	2000	psia
Current Bubble Pt Pressure	2000	psia
Current Solution GOR	435.8	scf/bbl
Current Oil Viscosity	1.246	cp

Screening Results

IOR/EOR Process	Yes/No	Failed Criteria
Horizontal Wells	YES	
Waterflood	YES	
Hot Water Inj	No	(1) (4) (10) (16)
Steam Inj	No	(1) (3) (4) (6) (10) (16)
Huff & Puff	No	(1) (4) (10) (16)
Immiscible Gas Inj	No	(4) (10)
In-Situ Combustion	No	(3) (4) (10) (16)
Hydrocarbon Miscible Inj	No	(4) (10) (12)
CO ₂ Miscible Inj	No	(4) (10) (12)
Nitrogen Miscible Inj	No	(4) (10) (12) (15)
Polymer Inj	No	(4) (5) (16) (18) (19)
Alkaline Inj	No	(4) (6) (9) (18) (19) (20)
Surf/Poly Inj	No	(3) (4) (6) (18) (19)
ASP Inj	No	(3) (4) (6) (18) (19) (20)
Micellar Inj	No	(3) (4) (6) (18) (19)
High Pressure air Inj	No	(4) (10) (15)
Surface Mining	No	(16)
Horizontal SAGD	No	(1) (2) (3) (4)

Exit Program

Load PE Tools EOR/Heavy Oil Model

Save EOR/Heavy Oil Model to PE Tools dB

Info

Oilfield

Open PE dB

Capture Screen

Model Name:

EOR Tools

IOR/EOR Screening Tool

PEE Tools Examples Database.PEEdb

Minimum Miscibility Pressure

Oil Analysis

H2S - mol-%	0
N2 - mol-%	0.18
CO2 - mol-%	0.44
C1 - mol-%	43.92
C2 - mol-%	10.71
C3 - mol-%	8.81
iC4 - mol-%	1.3
nC4 - mol-%	3.99
iC5 - mol-%	1.36
nC5 - mol-%	1.83
C6 - mol-%	2.55
C7+ - mol-%	24.91
Σ Comps	100
C7+ MW	231
C7+ Specific Gravity	0.855

Injectant

N2 - mol-%	0.29
CO2 - mol-%	0.76
C1 - mol-%	73.05
C2 - mol-%	13.95
C3 - mol-%	8.17
C4 - mol-%	2.66
C5 - mol-%	0.62
C6 - mol-%	0.5
Σ Comps Inj	100
Res Temperature	150 °F

Correlation

Gas Injection

- ☐ Glasco (1985) [1]
- ☒ Maklavani (2010) [2]

100% N₂ Injection

- ☐ Glasco (1985) [1]
- ☐ Firoozabadi (1986) [3]
- ☐ Seabastion (1992) [4]

100% CO₂ Injection

- ☐ Glasco (1985) [1]
- ☐ Zang (2015) [5]
- ☐ Chen (2013) [6]
- ☐ Yuan (2005) [7]
- ☐ Cronquist (1978) [8]

Correlation Limits

References

4734.681 psi

Minimum Miscibility Pressure

Reservoir Thermal Properties

Oil API	20
Porosity (%)	25
Oil Saturation (%)	50
Water Saturation (%)	50
Res Temperature (°F)	122
Shale Content (%)	0
Matrix Density (g/cc)	2.65
Oil SG at Res Temperature	0.908
Water SG at Res Temperature	0.9989
Oil Specific Heat (BTU/lb-°F)	1.003
Water Specific Heat (BTU/lb-°F)	1.071
Rock Specific Heat (BTU/lb-°F)	0.198
Res Heat Capacity (BTU/ft ³ -°F)	3566.6
Thermal Conductivity (BTU/h-ft-°F)	1.56

Hot/Cold Water Injection

Water Temperature (°F)	212
Water Injection Rate (bwpd)	3145
Reservoir Temperature (°F)	98.6
Formation Thickness (ft)	19.7
Res Heat Capacity (BTU/ft ³ -°F)	3566.6
Injection Time (days)	100
Plot Distance From Well (ft)	49.2
Water SG at Injection Temperature	0.9589
Water Specific Heat (BTU/lb-°F)	1.003
Temperature at 'Distance' (°F)	208.7

Reservoir Temperature Distribution

°F vs distance from well (ft)

PCP Pump Rates

Eccentricity of Rotor/Stator (in)	1.968
Rotations per Minute	150
Rotor Diameter (in)	1.575
Stator Pitch, Ps (in)	1.575
Volumeetric Efficiency (%)	100
PCP Pump Flow Rate (lbbls/d)	43.5

Sucker Rod Pump Rates

Pump Speed, Strokes per Min	5
Plunger Area (in ²)	50
Effective Plunger Stroke (ft)	1
Volumeetric Efficiency (%)	100
Sucker Rod Pump Flow Rate (lbbls/d)	445.2

SteamFlood Residual Oil Saturation

Oil viscosity at Res Temp (cp)	18000
SteamFlood Temperature (°F)	399
S _{or} after SteamFlood (%)	8.2

°F	S _{or}	°F	S _{or}	°F	S _{or}
200	19.4	340	11.6	480	3.7
220	18.3	360	10.4	500	2.6
240	17.2	380	9.3	520	1.4
260	16	400	8.2	540	0.3
280	14.9	420	7.1	560	0
300	13.8	440	5.9	580	0
320	12.7	460	4.8	600	0

Export Data

Save Graph

• Field Development Planning (Multi-well Project Scheduling, Planning and Forecasting)

Exit Program Load PE Tools Model Type Curve Well Data PVT Data Quick Plot Export Forecast to CSV Save Forecast to PE Tools dB Save Model to PE Tools dB Info

Oilfield Run Development Plan View Well Parameters

G/O/W Model PE dB Forecasts

Model Name: FDP Example Oil Current Forecast Day: 1669 Output Frequency ☒ Monthly ☐ Daily

Well Drilling and Completion Plan

Measured Well Depth (ft) 8000
Drilling Rate of Penetration (ft/day) 100
Time to Complete/Tie-in Well (days) 10

☒ Pad Drilling: #Wells/Pad 6

Time to Drill Pad (days) 480
Time to Pad On Line (days) 540

Production Parameters

Minimum Well Oil Rate (bopd) 100
Maximum Well Water Cut (%) 99
Minimum FBHP (psi) 500

☒ Forecast Pressure

Statistical Parameters

☒ Productivity
☒ Rig Availability
☒ Facility UpTime

Set Statistical Parameters

Forecast Results

Total OOIP (mmbbls)	7180	Max Well Count	16
Final EUR (mmbbls)	2439	Final Prod Wells	1
Peak Rate (bopd)	4246	Peak SI (bopd)	251
Peak Water (bwpd)	676	Forecast Years	4.6

Year	Month	Oil Rate bopd	Gas Rate mscf/d	Wat Rate bwpd	Oil Cum mmbbls	Gas Cum mmcf	Wat Cum mmbbls	# Wells	SI Rate bbls/d
2018	May	2040.1	750.8	2	63.243	23.3	0.063	6	113
2018	Jun	1845.7	679.2	1.8	118.615	43.7	0.119	6	102
2018	Jul	1684.2	619.8	144.7	170.827	62.9	4.603	6	93
2018	Aug	1545.8	568.8	281.5	218.746	80.5	13.328	6	85
2018	Sep	1429.4	526	283.6	261.628	96.3	21.835	6	79
2018	Oct	1328.7	489	285.4	302.819	111.4	30.682	6	73
2018	Nov	1240.8	456.6	287	340.043	125.1	39.291	6	68
2018	Dec	1163.4	428.1	288.4	376.108	138.4	48.229	6	64
2019	Jan	1093.6	402.5	289.6	410.011	150.9	57.207	6	60
2019	Feb	1034.3	380.6	290.6	438.971	161.5	65.344	6	57
2019	Mar	980.8	364	291.5	469.376	172.8	74.38	6	54
2019	Apr	927.1	353.3	291.1	497.188	183.4	83.113	6	55
2019	May	882.1	347.4	291.8	524.532	194.2	92.158	6	53

Facility Parameters

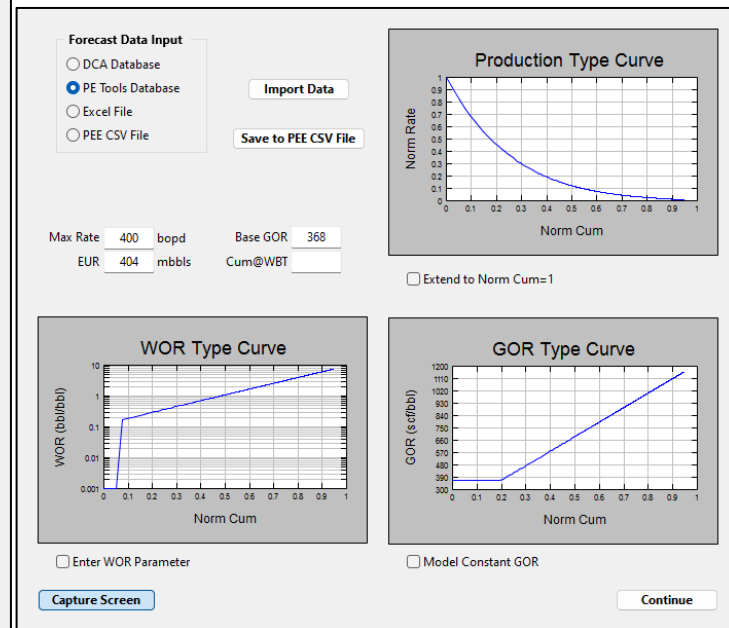
Maximum Oil Capacity 1000000 bopd
Maximum Gas Capacity 50000 mscf/d
Minimum Capacity 100 bopd

Start-up Month 5 (Jan = 1)
Start-up Year 2018

Average Facility Uptime 100 %

Oil Rate vs Time (yrs)

Oil Cum vs Time (yrs)



Well Options

☐ Vertical Well ☐ Annular Flow
☒ Horizontal Well

MD to Top Perf (ft) 8000 FTHT (°F) 75
TVD to Top Perf (ft) 8000 Well Drainage Acres 25
Tubing ID (in) 2.441 Permeability .2
Tubing OD (in) 3.5 Net Pay (ft) 300
Depth of Tubing (ft) 8000 Skin <> -5
Casing ID (in) 6

Tubing Correlation Hagedorn-Brown

Statistical Production / Well Parameters

Well #	Q _i (bopd)	EUR (mmbbls)	Perm (md)	Pay (ft)
1	400	404	0.2	300
2	396.5584	400.3219	0.1981792	297.2688
3	390.1018	394.0028	0.1959509	292.5763
4	422.3288	426.5521	0.2111644	316.7466
5	323.1419	326.3733	0.161571	242.3564
6	333.249	336.5615	0.1664245	249.9368
7	343.1977	346.6297	0.1715988	257.3983
8	354.1736	357.7153	0.1770868	265.6302
9	365.3004	369.7362	0.1827902	274.1833
10	377.2089	380.981	0.1886045	282.9067
11	389.7066	393.6037	0.1946333	292.28
12	402.5699	406.835	0.2014035	302.1052
13	416.6914	420.8583	0.2083457	312.5186
14	431.8593	436.1244	0.2159832	323.8547
15	447.8674	452.1641	0.2239477	335.7655
16	466.1489	470.8104	0.2330744	349.6116
17	477.4318	476.1461	0.2337159	353.5739
18	377.5821	381.3579	0.1887911	283.1866

Random Number Seed: 12362

Import PVT Properties

Oil/Cond API 40
Separator Gas Gravity 0.8
Separator Pressure (psi) 114.7
Separator Temperature (°F) 60

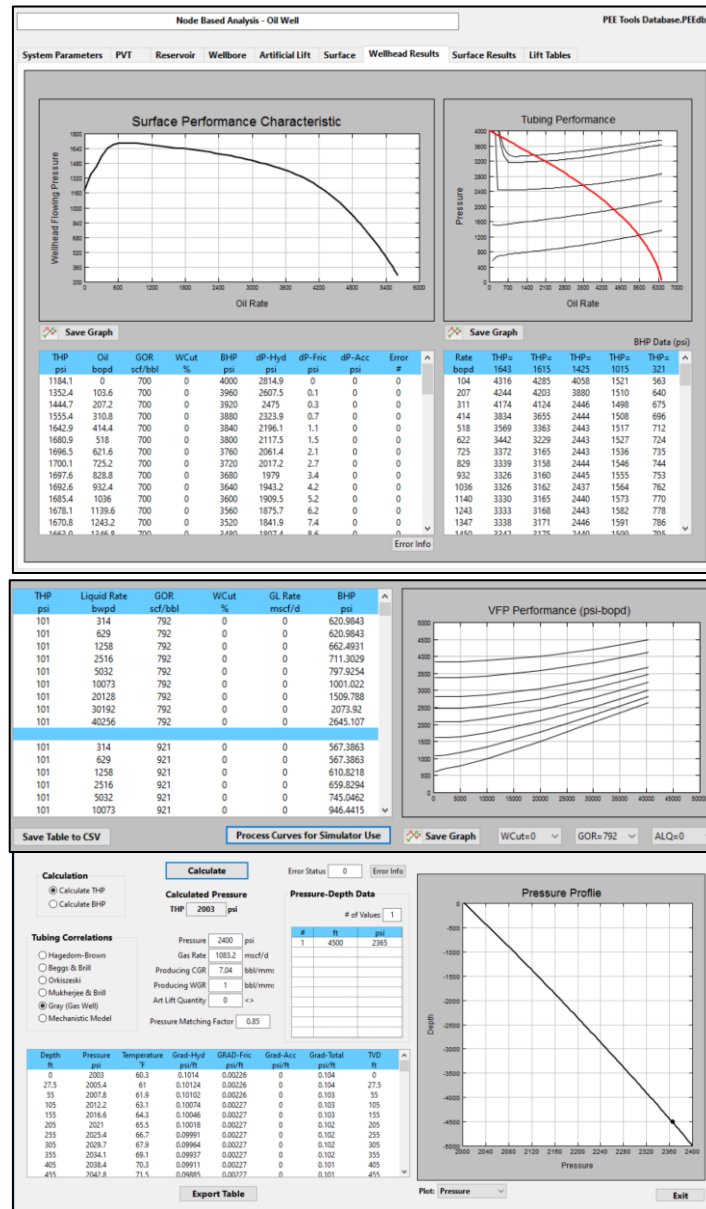
Reservoir Pressure (psi) 4800
Reservoir Temp (°F) 160

H₂S - mol% 0
N₂ - mol% 0.47
CO₂ - mol% 1.81

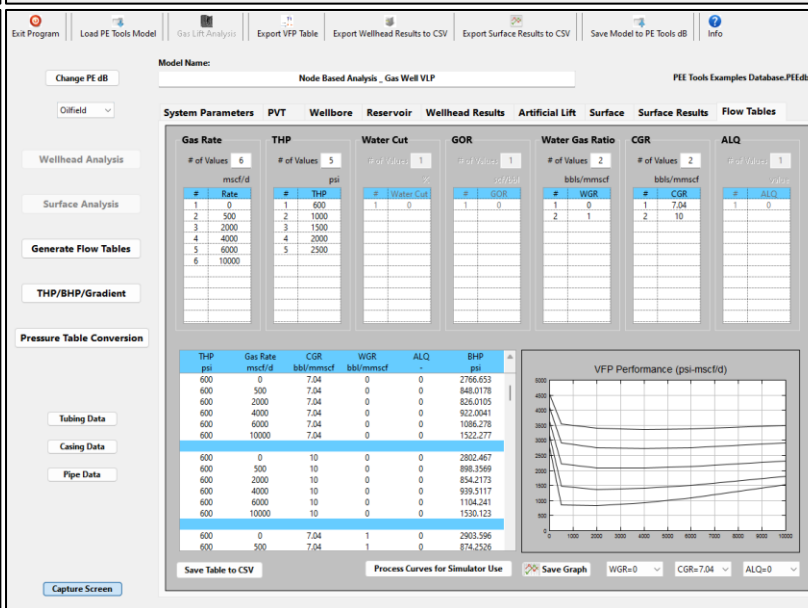
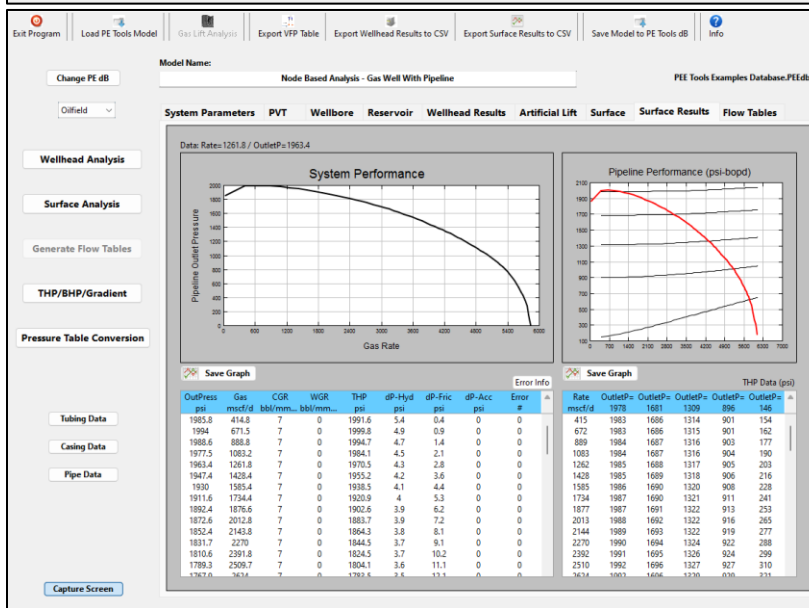
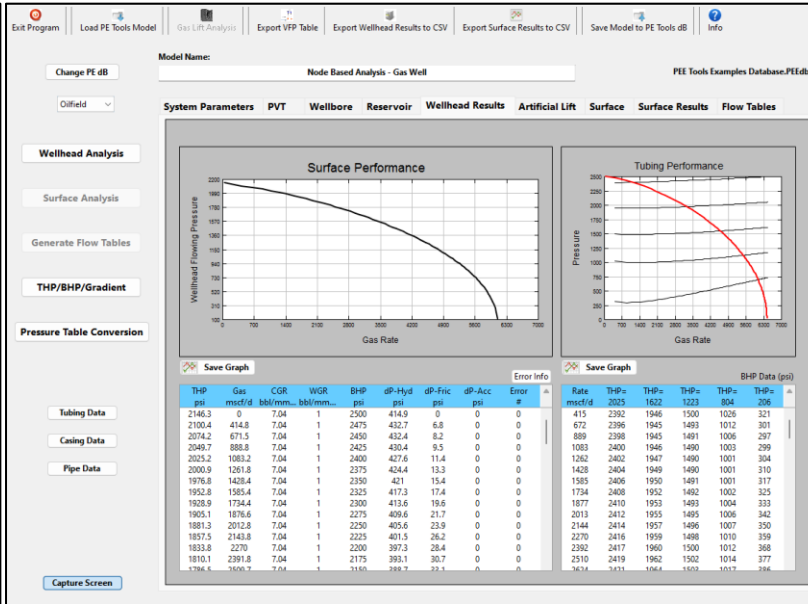
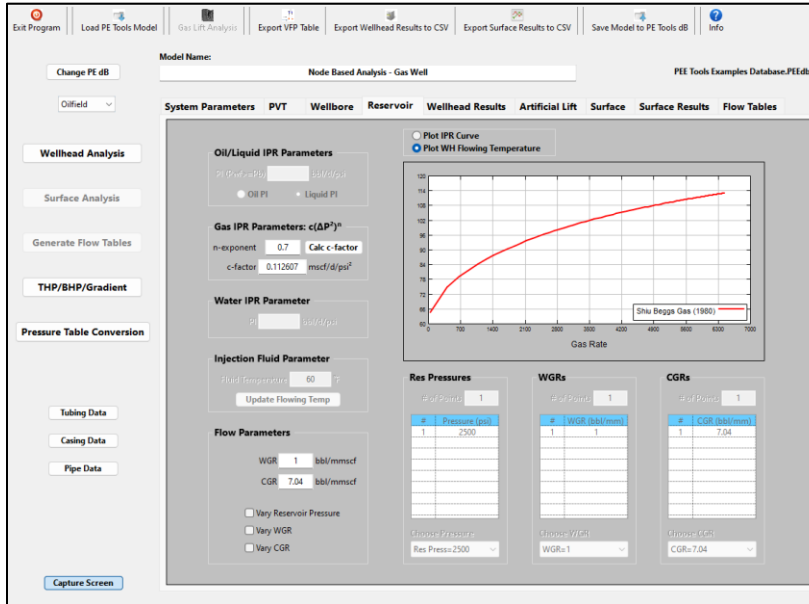
Corrected Gas G 0.7859
Gas P_c (psi) 672.2
Gas T_c (°R) 417.2

Bubble Point Pressure (psi) 1442
GOR (scf/bbl) 368
Water Salinity (ppm NaCl) 30000

• Nodal Analysis (1)



• Nodal Analysis (2)



• Interference Analysis

Interference Plot Settings

Plot Group #1- Forward

Title: PE Interference - Forward

y Label: BHP & Norm-WI Rate

Interfering Well: Y-Scaling Factor: 1

Interfering Well: Y-Shift: 0

y Axis: Maximum: 10000 Minimum: 0

x Axis: Maximum: 1000 Minimum: 0

Reset Y Reset X

Plot Group #1- Reverse

Title: PE Interference - Reverse

y Label: WI Rate & Norm-BHP

Interfering Well: Y-Scaling Factor: 1

Interfering Well: Y-Shift: 0

y Axis: Maximum: 29000 Minimum: 0

x Axis: Maximum: 2200 Minimum: 0

Reset Y Reset X

Plot Group #2- Forward

Title: PE Interference - Forward

y Label: Liquid Prod & Norm-WI Rate

Interfering Well: Y-Scaling Factor: 0.5

Interfering Well: Y-Shift: 11000

y Axis: Maximum: 40000 Minimum: 0

x Axis: Maximum: 2200 Minimum: 0

Reset Y Reset X

Plot Group #2- Reverse

Title: PE Interference - Reverse

y Label: WI Rate & Norm-Liquid Pro

Interfering Well: Y-Scaling Factor: 1

Interfering Well: Y-Shift: 0

y Axis: Maximum: 29000 Minimum: 0

x Axis: Maximum: 2200 Minimum: 0

Reset Y Reset X

General Settings

☒ Show Grid ☐ Show Minor Grid ☐ Show Legend top right

Text

Text Font: System

Axis Label Size: 10

Tick Label Size: 10

Title Size: 12

Legend Text Size: 10

Series Settings (Select Series First)

Series Color: Black

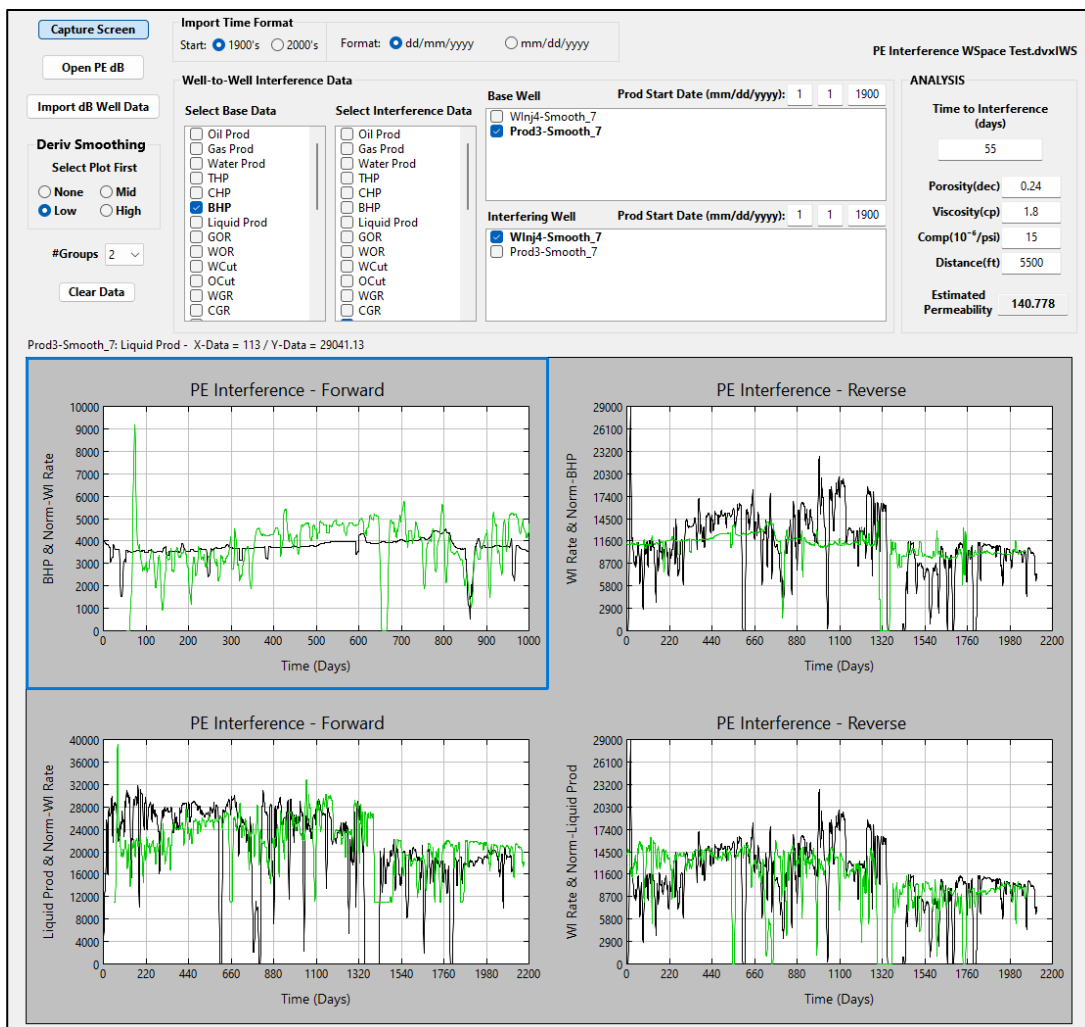
Line Style: solid

Line Width: 1

Marker Style: none

Marker Size: 7

☐ Solid Marker



Prod3-Smooth_7; Liquid Prod - X-Data = 113 / Y-Data = 29041.13

PE Interference - Forward

PE Interference - Reverse

PE Interference - Forward

PE Interference - Reverse

- Recovery Factor Analysis – Oil, Monte Carlo Oil, Gas, Unconventional, Reservoir Complexity and Artificial Neural Network (World Oil, March 2019)

Exit Program Load PE Tools Model Neural Network Export MC Results to CSV File Save Model to PE Tools dB Info

Oilfield Capture Screen Open PE dB Model Name: Recovery Factor PEE Tools Examples Database.PEEdb

Deterministic / Probabilistic 'API' Oil Recovery Factor

	P90	P50	P10	
Initial Reservoir Pressure, Pi	3000	3500	4000	psi
Bubble Point Pressure, Pbp	2500	2600	2700	psi
Abandonment Pressure, Pab	1500	1750	2000	psi
Permeability, k	1000	1500	2000	md
Porosity, phi	15	17	20	%
Initial Water Saturation, Sw	20	25	30	%
Reservoir Temperature, TR	175	180	185	°F
Oil Gravity	32	35	38	API
Gas Gravity, G	0.65	0.67	0.69	<>
Water Salinity	30000	35000	40000	ppm
Boi	1.253	1.294	1.34	bbbl/bbl
Bob	1.26	1.306	1.359	bbbl/bbl
μoi	0.9	0.701	0.564	cp
μob	0.857	0.64	0.493	cp
μw	0.381	0.373	0.366	cp
Solution Gas Drive (SGD) Oil RF	17.5	20	22.4	%
Strong Water Drive/Flood (WD) Oil RF	54.4	54.9	55.1	%

Seed (Random=-1) 12345 MC Simulation
M-C Simulations 10000

Monte Carlo Results: Oil Recovery Factor

	SGD	WD	SGD	WD	SGD	WD		
P1	21.34	59.57	P40	19.08	53.1	P80	17.78	50.11
P10	20.2	56.13	P50	18.78	52.39	P90	17.2	48.96
P20	19.76	54.73	P60	18.48	51.68	P99	15.66	45.84
P30	19.41	53.85	P70	18.14	50.95	EV	18.74	52.47

Gas Recovery Factor

Gas Gravity, G 0.65 <> Temperature, TR 175 °F
Initial Pressure, Pi 3500 psi Initial Sw 20 %
Abandon Pressure, Pab 2000 psi Residual Gas, Sgr 25 %

Reservoir System / RF

Recovery Factor 81.6 %
Suggested, Sgr 23.7 %
☐ Volumetric Gas
☒ Limited Water Drive
☐ Strong Water Drive

Unconventional Gas Recovery Factor (Empirical)

Initial Gas Resource in Place 100 Tscf
Potential Gas RF 17.6 % Potential Field IP 4900.4 mmscf

Unconventional Oil Recovery Factor (Empirical)

Initial Oil Resource in Place 100 Bbbls
Potential Oil RF 4.6 % Potential Field IP 767.6 mbopd

Oil Recovery Factor Based on Reservoir Complexity Index

Structural Complexity

☐ No Faulting / Excellent Reservoir Quality / High Perm

☒ Some Faulting / Some Isolated Fault Blocks / Good Perm

☐ Highly Faulted / Major and Minor Faults

☐ Highly Faulted / Naturally Fractured / Moderate Perm

☐ Highly Discontinuous / Sealed Fault Blocks / Gas/Water Coning / Low Perm

Oil Viscosity

☐ Oil Viscosity < 1 cp

☐ Oil Viscosity Between 1 cp and 10 cp

☒ Oil Viscosity Between 10 cp and 100 cp

☐ Oil Viscosity Between 100 cp and 1000 cp

☐ Oil Viscosity > 1000 cp

OOIP Areal Density

☐ > 115,000 bbls/acre

☒ Between 51,000 bbls/acre and 115,000 bbls/acre

☐ Between 25,000 bbls/acre and 51,000 bbls/acre

☐ Between 12,500 bbls/acre and 25,000 bbls/acre

☐ < 12,500 bbls/acre

Perm Heterogeneity

☒ 1<Kmax/Kmin<10 or Dykstra-Parsons: <0.6

☐ 10<Kmax/Kmin<100 or Dykstra-Parsons: 0.6 to 0.8

☐ 100<Kmax/Kmin<1000 or Dykstra-Parsons: 0.8 to 0.9

☐ 1000<Kmax/Kmin<10000 or Dykstra-Parsons: 0.9 to 1

☐ Kmax/Kmin>10000 or Dykstra-Parsons = 1

Normalized Reservoir Complexity Index (RCI) 0.313 RCI-Based Oil RF 34.7 %

☒ Sandstone
☐ Limestone/Dolomite

ANN Model
☒ Model 1 ☐ Model 2 Info

ANN Oil Recovery Factor - Conventional Reservoir

	Min	Max
Oil In Place	10	50000 mmbbls
Permeability	1	5000 md
Net Pay	10	1800 feet
Porosity	5	35 %
Oil Gravity	15	55 °API
Oil Viscosity	0.1	88 cp
Oil RF	4	78 %

ANN-Based Oil Recovery Factor 34.5

Run ANN Model

Capture Screen Exit

- Includes scoping economics analysis
- Includes basic corporate economics tool

Exit Program Load PE Tools Model Production Profile Oil/Gas Price Profile Corporate Economics Export Project Results to CSV Export Corporate Results to CSV Save to PE Tools dBase Info

Open PE dB Run Project Economics

Oilfield PE dBase Forecasts Capture Screen

Model Name: Unconventional Gas Well

Economics' Run Year to Start Discounting (Full Cycle Economics) 1
All Cash in \$MM / Oil and Water in bbl/d and mmbbls / Gas in mscf/d and mmcf

Economic Results

Oil Reserves	393.3	NPV10	8.5	Total Cap Costs	6.1	PIR (disc) (\$/S)	0
Gas Reserves	7356	Econ Life (yrs)	26	Max Exposure	-6.1	Break Even Year	2

Oil/Gas Prices

Oil Price (\$/bbl)	-1
Gas Price (\$/mcf)	-1
Price Esc Cap	1.2

Annual Discount Rate (%) 10
Project - IRR (%) 121.3

Operating Costs

Head Office Overhead (\$mm/yr)	0.5
Fixed Well Op Costs (\$k/yr)	34
Variable Well Costs - Gas (\$/mcf)	0.25
Variable Well Costs - Oil (\$/bbl)	0
Gas Transportation Fee (\$/mcf)	0.75
Oil Transportation Fee (\$/bbl)	0
Gas Processing Fee (\$/mcf)	0.5
Oil Processing Fee (\$/bbl)	0
Water Disposal Fee (\$/bbl)	0

Well Capital Costs

Total Measured Well Depth (ft)	4500	Cost to Drill Well (\$k)	2250
Drilling Rate of Penetration (ft/day)	200	Total Well Cost (\$k)	5100
Daily Drilling Costs (\$k/day)	100		
Well Completion Cost (\$k/well)	2600	Time to Drill Well (days)	22.5
Well Tie-In and Misc Costs (\$k/well)	250	Time to Well On Line (days)	32.5
Time to Complete/Tie-in Well (days)	10		

Facility/Project Capital Costs

Pre-Startup Project Costs (\$MM)	1
Ongoing Project Costs (\$MM/yr)	0
Length of Time for Costs (#yr)	0

Well Count / Well Profile

Initial #Well	1
Final #Well	1

Base Oil Rate (bopd) Project Oil Rate (bopd) Cum Annual Disc CF (\$MM)

Base Oil Rate Save Graph Project Oil Rate Save Graph Cum Annual Disc CF Save Graph

Run Corporate Economics

Corporate Economic Results - After Tax

Oil Reserves	389.4	NPV10	8.5	Total Cap Costs	6.1	PIR (disc) (\$/S)	1.4
Gas Reserves	7284	Econ Life (yrs)	25	Max Exposure	-6.1	Break Even Year	2

After Tax - IRR (%) 121.3
Corporate NPV @ 0% 18
Corporate NPV @ 7% 10.4
Corporate NPV @ 10% 8.5
Corporate NPV @ 12% 7.6
Corporate NPV @ 15% 6.4
Corporate NPV @ 20% 4.9

Taxes and Royalties Parameters

Cost Recovery Uplift (\$mm)	0
Working Interest Before P/O (%)	100
Working Interest After P/O (%)	100
Over-Riding Royalty (%)	0
Corporate Income Tax Rate (%)	0
Time to Depreciate CapEx (yrs)	1
Royalty Rate Before P/O (%)	0
Royalty Rate After P/O (%)	0

Company Oil Rate (bopd)

Company AT Cum DCF (\$MM)

Company Oil Rate Save Graph Company AT Disc Cum Cash Flow Save Graph

Exit Capture Screen

Production Profile Import

PE Tools db DCADatabase
Excel File Link to Excel

Fluid Type

Oil
Gas

Well Name/Info Unconventional Gas Well

Excel Import Parameters

Column Letter	Start Row	End Row
Time in Years		
Oil/Condensate Daily Rate		
Gas Daily Rate		
Water Daily Rate		
Cum Oil Volume		
Cum Gas Volume		
Cum Water Volume		

Import Data Save to PE Tools db
Capture Screen Continue

Note: Gas in mscf/d and mmcf and Oil/Water in bbl/d and mmbbls

Years	bopd	mscf/d	bwpd	mmbbls	mmcf	mmbbls
0	817.17	15000	4.41	0	0	0
0	817.17	15000	4.41	0.07	1.4	0
0	817.17	15000	4.41	0.16	2.9	0
0	817.17	15000	4.41	0.24	4.4	0
0	817.17	15000	4.41	0.32	5.9	0
0	817.17	15000	4.41	0.4	7.4	0
0	817.17	15000	4.41	0.48	8.9	0
0	817.17	15000	4.41	0.56	10.4	0
0	817.17	15000	4.41	0.65	11.9	0
0	817.17	15000	4.41	0.73	13.4	0
0	817.17	15000	4.41	0.81	14.9	0
0	817.17	15000	4.41	0.89	16.4	0
0	817.17	15000	4.41	0.97	17.9	0.01
0	817.17	15000	4.41	1.05	19.4	0.01
0	817.17	15000	4.41	1.14	20.9	0.01
0	812.45	14915.29	4.38	1.22	22.4	0.01
0	806.53	14804.63	4.35	1.3	23.8	0.01
0	799.63	14677.91	4.31	1.38	25.3	0.01
0	793.15	14558.98	4.28	1.46	26.8	0.01
0.01	787.2	14449.84	4.25	1.54	28.2	0.01
0.01	781.54	14345.9	4.22	1.61	29.7	0.01
0.01	773.22	13532.36	3.98	2.35	44	0.01
0.01	701.18	12870.91	3.78	3.05	57.6	0.02
0.01	673.56	12363.81	3.63	3.73	70.4	0.02
0.02	649.95	11930.5	3.51	4.38	82.8	0.02
0.02	628.98	11545.45	3.39	5	94.7	0.03
0.02	610.62	11208.44	3.29	5.62	106.3	0.03
0.04	527.75	9687.44	2.85	9.31	184.7	0.05

- Comprehensive Asset Economics Evaluation (1)

Exit Program
Load Asset DataBase
Load Asset
Purchase Options
Corporate Plots
Export Results to File
Save Asset DataBase
Save Asset
Lock Asset db
Unlock Asset db
Info

Oilfield
New Asset dBase
Open PE dB
Remove Asset
Duplicate Asset
Asset
PSC Model - Cum Based PSC Esc 100WI

Run Asset Economics
Show Sensitivities

Asset Model
Production Forecast Data
Model Parameters
Capital Costs
Operating Costs
Fiscal Regime

Project - IRR (%) 405.5
Corporate AT IRR (%) 95.5
Max Discount Factor
Corporate AT NPV 1309.9 0 %
Corporate AT NPV 870.4 7 %
Corporate AT NPV 730.4 10 %
Corporate AT NPV 555 15 %
Corporate AT NPV 431.3 20 %
Corporate AT NPV 274.3 30 %

Model Name: PSC Model - Cum Based PSC Esc 100WI

Project Oil Rate (bopd)
Cum Annual Disc CF (\$MM)

Project Oil Rate
Save Graph
Cum Annual Disc CF
Save Graph

Capture Screen
PE Essentials Asset DataBase.DVXcdb

All Cash in US\$MM / Oil and Water in bbls/d and mbbls / Gas in mscf/d and mmcf

Project Economic Results
Oil Reserves 180923 NPV7 5552.7 Disc Cap Costs 351.7 Discounted PIR 15.79
Gas Reserves 0 Econ Life (yrs) 29 Max Exposure -150 Break Even Year 2018

Year	Inc Wells	Active Wells	Oil Rate	Gross Gas Rate	Water Rate	Oil Cum	Net Gas C
Init	1	1	25890	0	0	0	0
2018	0	1	25890	0	0	9449.9	0
2019	0	1	32750	0	0	11953.7	0
2020	0	1	34490	0	0	12588.8	0
2021	0	1	34930	0	0	12749.5	0
2022	0	1	33750	0	0	12318.8	0
2023	0	1	31900	0	0	11643.5	0
2024	0	1	32280	0	0	11782.2	0
2025	0	1	30370	0	0	11085	0
2026	0	1	28309.8	0	0	10333.1	0
2027	0	1	25950.1	0	0	9471.8	0
2028	0	1	23940	0	0	8738.1	0
2030	0	1	21600.8	0	0	7887.6	0

Corporate Economic Results - After Tax
Oil Reserves 180923 NPV7 870.4 Disc Cap Costs 351.7 Discounted PIR 2.48
Gas Reserves 0 Econ Life (yrs) 29 Max Exposure -150 Break Even Year 2019

Years	Net Oil Rate	Net Gas Rate	Net Oil Cum	Net Gas Cum	Gross Revenue	PSC Roy
Init	25890	0	0	0	0	0
2018	25890	0	9449.9	0	557.541	72.4
2019	32750	0	21403.6	0	717.225	100.4
2020	34490	0	33992.5	0	755.331	105.7
2021	34930	0	46741.9	0	986.297	147.9
2022	33750	0	59060.7	0	970.348	145.5
2023	31900	0	70704.2	0	933.809	149.4
2024	32280	0	82486.4	0	962.252	163.5
2025	30370	0	93571.4	0	921.833	156.7
2026	28309.8	0	103904.5	0	875.007	148.7
2027	25950.1	0	113376.3	0	816.848	138.8
2028	23940	0	122114.4	0	767.38	130.4
2030	21600.8	0	130007	0	705.467	110.0

Asset Economic Sensitivities				
NPV7 870.4		Capture Screen	All Cash in US\$MM	
Production	CapEx	OpEx	Oil Price	Gas Price
-30% 514.2	-30% 911.8	-30% 1018.2	-30% 387.9	-30% 870.4
-25% 579.3	-25% 904.3	-25% 993.6	-25% 474.7	-25% 870.4
-20% 647.7	-20% 897.1	-20% 969	-20% 558.5	-20% 870.4
-15% 711.8	-15% 890	-15% 944.5	-15% 639.6	-15% 870.4
-10% 760.2	-10% 883.2	-10% 919.9	-10% 719.7	-10% 870.4
-5% 817.5	-5% 876.7	-5% 895.3	-5% 796.5	-5% 870.4
0% 870.4	0% 870.4	0% 870.4	0% 870.4	0% 870.4
+5% 917.9	+5% 864.1	+5% 843	+5% 941.5	+5% 870.4
+10% 978.7	+10% 858.1	+10% 812.7	+10% 1012.1	+10% 870.4
+15% 1024.7	+15% 852.4	+15% 781.1	+15% 1082.8	+15% 870.4
+20% 1070.1	+20% 846.9	+20% 747.4	+20% 1153.5	+20% 870.4
+25% 1129.3	+25% 841.7	+25% 713.6	+25% 1224.1	+25% 870.4
+30% 1167.1	+30% 836.7	+30% 678.3	+30% 1294.8	+30% 870.4
Return				

- Comprehensive Asset Economics Evaluation (2)
 - In-depth annual economic input parameters
 - Three fiscal regimes: Taxes and Royalties; PSC; and Service Contract

Asset Production Data Import

Fluid Type
☒ Oil
☐ Gas

Annual Fuel and Flare Gas Volume
 0

Info: PSC Model - Cum Based PSC Esc 100W

Rates in bbl/d for liquid and mcf/d for gas. Volumes in mbbls for liquid and mmcf for gas.

Date	Years	Qo	Qg	Qw	CumO	CumG	CumW	#Wells
2019	0	25890	0	0	0	0	0	1
2020	1	25890	0	0	94803.5	0	0	1
2021	2	32750	0	0	214603.5	0	0	1
2022	3	34490	0	0	33992.45	0	0	1
2023	4	34820	0	0	46741.9	0	0	1
2024	5	33750	0	0	59600.65	0	0	1
2025	6	31900	0	0	70704.15	0	0	1
2026	7	32080	0	0	82446.35	0	0	1
2027	8	30370	0	0	93571.4	0	0	1
2028	9	28310	0	0	102954.5	0	0	1
2029	10	25950	0	0	113375.5	0	0	1
2030	11	23940	0	0	122144.4	0	0	1
2031	12	21610	0	0	130002	0	0	1
2032	13	19170	0	0	136999.1	0	0	1
2033	14	17580	0	0	143415.8	0	0	1
2034	15	15970	0	0	149244.8	0	0	1
2035	16	13430	0	0	154148.8	0	0	1
2036	17	10440	0	0	158241.4	0	0	1
2037	18	10810	0	0	162414	0	0	1
2038	19	9190	0	0	165830.4	0	0	1
2039	20	8190	0	0	168519.8	0	0	1
2040	21	7100	0	0	171444.1	0	0	1
2041	22	6020	0	0	174522.4	0	0	1
2042	23	5140	0	0	177525.5	0	0	1
2043	24	4310	0	0	177701.6	0	0	1
2044	25	3810	0	0	178419.3	0	0	1
2045	26	2880	0	0	179475.5	0	0	1
2046	27	2270	0	0	180299	0	0	1
2047	28	1710	0	0	180923.2	0	0	1

Import Oil Rate (bopd)

Buttons: Open PE dB, PE dB Forecasts, Import Forecast Data, Import Data from DCA Database, Save Forecast to PE Tools dbase, Import Oil Rate, Save Graph, Clear Table, Capture Screen, Return

Asset Model Parameters

Capture Screen

Asset Name: CAPE Asset 1

Annual Discount Rate (%) 7

Start Year 2019
Start Month (P) 1

Year to Start Discounting (Full Cycle Economic) 2019

Oil/Gas Prices
 Oil Price (US\$/bbl) -1
 Gas Price (US\$/mcf) -1
 Oil Price Differential (%) 7
 Gas Price Premium (US\$/) 0
 View Oil/Gas Price Profile

Escalation Factors
 Oil Price (%) 0
 Gas Price (%) 2
 CapEx (%) 2
 OpEx (%) 2
 Oil/Gas Trans (%) 2
 Oil/Gas Processing (%) 2
 Water Disposal (%) 2

Annual Escalation Factors

Date	Year	Oil Price	Gas Price	CapEx	OpEx	Trans	Process	Disposal
2019	1	48.36	3.12	2	2	2	2	2
2020	2	49.29	3.12	2	2	2	2	2
2021	3	49.29	3.12	2	2	2	2	2
2022	4	65.43	3.18	2	2	2	2	2
2023	5	66.75	3.23	2	2	2	2	2
2024	6	68.08	3.31	2	2	2	2	2
2025	7	69.44	3.38	2	2	2	2	2
2026	8	70.81	3.45	2	2	2	2	2
2027	9	72.24	3.51	2	2	2	2	2
2028	10	73.69	3.59	2	2	2	2	2
2029	11	75.16	3.66	2	2	2	2	2
2030	12	76.67	3.73	2	2	2	2	2
2031	13	78.2	3.8	2	2	2	2	2
2032	14	79.77	3.88	2	2	2	2	2
2033	15	81.36	3.96	2	2	2	2	2
2034	16	82.98	4.04	2	2	2	2	2
2035	17	84.65	4.12	2	2	2	2	2
2036	18	86.34	4.2	2	2	2	2	2
2037	19	88.07	4.28	2	2	2	2	2
2038	20	89.83	4.37	2	2	2	2	2
2039	21	91.62	4.46	2	2	2	2	2
2040	22	93.46	4.55	2	2	2	2	2
2041	23	95.33	4.64	2	2	2	2	2
2042	24	97.23	4.73	2	2	2	2	2
2043	25	99.16	4.82	2	2	2	2	2
2044	26	101.17	4.92	2	2	2	2	2
2045	27	103.18	5.02	2	2	2	2	2
2046	28	105.23	5.12	2	2	2	2	2
2047	29	107.35	5.22	2	2	2	2	2
2048	30	109.6	5.38	2	2	2	2	2
2049	31	111.97	5.5	2	2	2	2	2
2050	32	114.37	5.62	2	2	2	2	2
2051	33	116.83	5.75	2	2	2	2	2
2052	34	119.32	5.88	2	2	2	2	2
2053	35	121.85	6.06	2	2	2	2	2

Import Price Data **Import Esc Data**
 Save Price Data to PE Tools db
 Save Esc Data to PE Tools db
 Open PE dB

Buttons: Clear Table, Return

Asset Capital Costs - Unescalated

Well Count / Well Profile / Capital

Total Well Cost (US\$MM) 6

Initial #Well 1
Final #Well 16

Facility / Project / Capital Costs

Pre-Start Costs (US\$MM) 150
Ongoing Costs (US\$MM/yr) -1
Length of Time for Costs (Fyr) 0

Abandonment Costs / Timing

Total Abandonment Costs (US\$MM) 184.7
Costs Spread Over How Many Years 1
Start Year for Expenditure 2027

Open PE dB **Import Cap Cost Data**
 Save Cap Costs to PE Tools db

Clear Table **Capture Screen** **Return**

Asset Operating Costs - Unescalated

Operating Costs

Date	Field	Fixed	Var-Oil	Var-Gas	Gas-Trans	Oil-Trans	Gas-Proc	Oil-Proc	Water Dis	Other
2019	129	0	5	0	0	1.5	0	0	0	0
2020	129	0	5	0	0	1.5	0	0	0	0
2021	129	0	5.5	0	0	1.5	0	0	0	0
2022	129	0	5.5	0	0	1.5	0	0	0	0
2023	129	0	5.5	0	0	1.5	0	0	0	0
2024	129	0	5.5	0	0	1.5	0	0	0	0
2025	129	0	5.5	0	0	1.5	0	0	0	0
2026	129	0	6	0	0	1.5	0	0	0	0
2027	129	0	6	0	0	1.5	0	0	0	0
2028	129	0	6	0	0	1.5	0	0	0	0
2029	129	0	6	0	0	1.5	0	0	0	0
2030	119	0	6	0	0	1.5	0	0	0	0
2031	117	0	6	0	0	1.5	0	0	0	0
2032	116	0	6	0	0	1.5	0	0	0	0
2033	108	0	6	0	0	1.5	0	0	0	0
2034	83	0	6	0	0	1.5	0	0	0	0
2035	83	0	6	0	0	1.5	0	0	0	0
2036	83	0	6	0	0	1.5	0	0	0	0
2037	83	0	6	0	0	1.5	0	0	0	0
2038	83	0	6	0	0	1.5	0	0	0	0
2039	83	0	6	0	0	1.5	0	0	0	0
2040	83	0	6	0	0	1.5	0	0	0	0
2041	85	0	5.5	0	0	1.5	0	0	0	0
2042	55	0	5.5	0	0	1.5	0	0	0	0
2043	45	0	5.5	0	0	1.5	0	0	0	0

Open PE dB **Import Op Cost Data**
 Save Op Costs to PE Tools db

Buttons: Clear Table, Capture Screen, Return

Asset Fiscal Terms

Open PE dB **Import Fiscal Terms**
 Save Fiscal Terms to PE Tools db

Fiscal Regime
☒ Taxes and Royalties Regime
☐ Production Sharing Contract
☐ Service Contract

Taxes and Royalty Parameters
 Cost Recovery (Rate %/Year) 0
 Working Interest Split (%) 100
 Working Interest Split (%) 100
 Terms Respective Split (%) 10

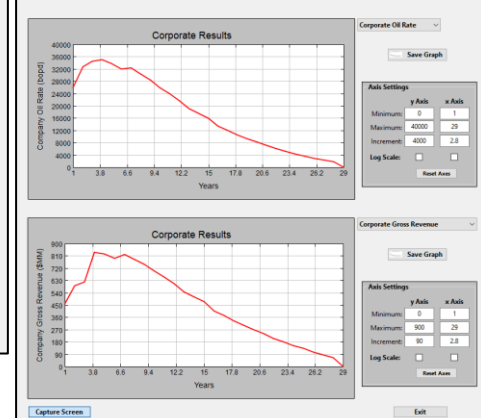
Service Contract Parameters
 Oil Royalty Rate (%) 0
 Gas Royalty Rate (%) 0
 Split Oil/Gas (%) 0
 Fixed Fee or Commission (%) 0
 Company Interest (%) 0
 Company Interest (%) 0
 Company Interest (%) 0
 Fixed Fee or Commission (%) 0

PSC Parameters
 Oil Royalty
☒ Rate Based Oil Royalty
☐ Rate Based Profit Oil Split
☐ R-Factor Based Oil Royalty
☐ R-Factor Based Profit Oil Split
 # of Intervals (x=10) 5
 # Min Cum (MM) 13
 # Max Cum (MM) 55
 # of Intervals (x=10) 5
 # Min Cum (MM) 13
 # Max Cum (MM) 55

Gov's Share of Profit Oil
☒ Rate Based Profit Oil Split
☐ Rate Based Profit Oil Split
☐ R-Factor Based Profit Oil Split
☐ R-Factor Based Profit Oil Split
 # of Intervals (x=10) 5
 # Min Cum (MM) 13
 # Max Cum (MM) 55

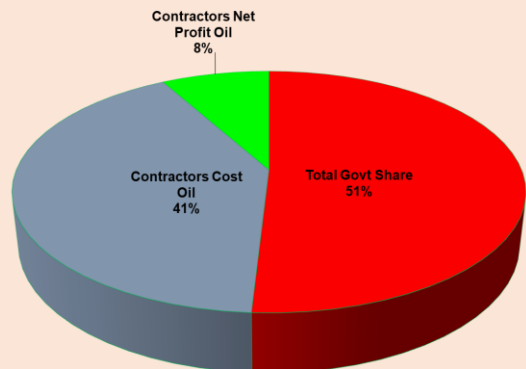
Gas Royalty Rate (%) 13
Corporate Income Tax Rate (%) 35
Cost Oil Ceiling (%) 65
Time to Depreciate CapEx (yrs) 5
Company Net Working Interest (%) 100

Clear Tables **Return**

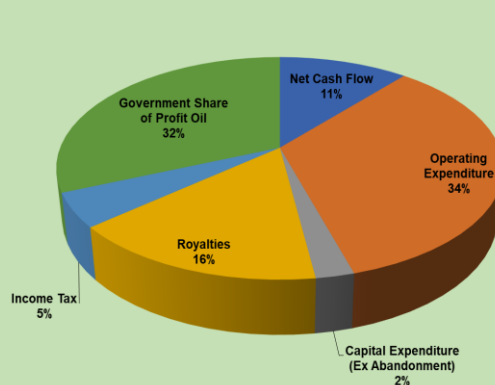


- Comprehensive Asset Economics Evaluation (3)
 - Excel export of results including graphical summaries

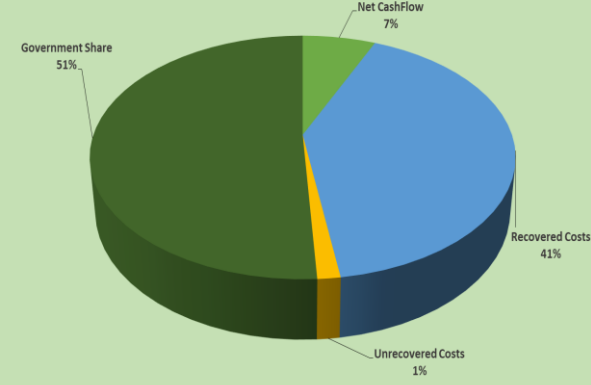
Summary: PSC Model - Cum Based PSC Esc 100WI



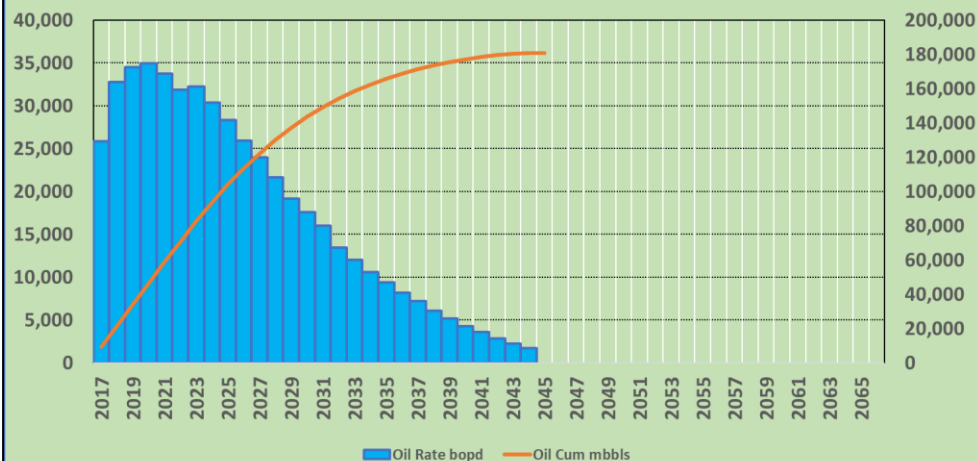
Revenue Split: PSC Model - Cum Based PSC Esc 100WI



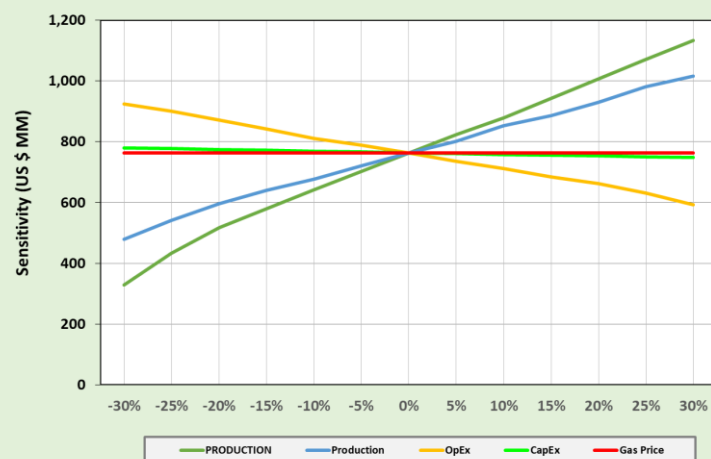
Revenue Split: PSC Model - Cum Based PSC Esc 100WI



Summary: PSC Model - Cum Based PSC Esc 100WI

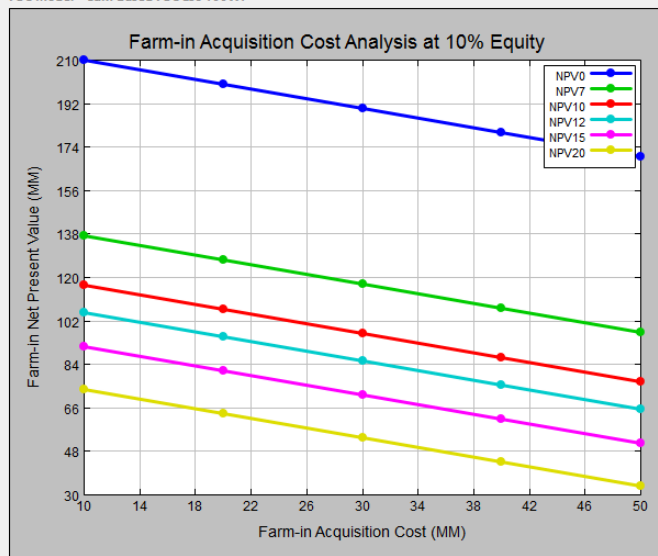


Sensitivity: PSC Model - Cum Based PSC Esc 100WI @ 180.9mmmbbls



- Comprehensive Asset Economics Evaluation (4)
 - Option for evaluation of acquisition economics

PSC Model - Cum Based PSC Esc 100WI



Run Acquisition Analysis

☒ Plot NPV ☐ Plot IRR

Equity Purchase (%) 10

Sensitivity: Acquisition Costs

of Acquisition Costs 5

#	Acquisition Cost
1	10
2	20
3	30
4	40
5	50

Save Results to Spreadsheet

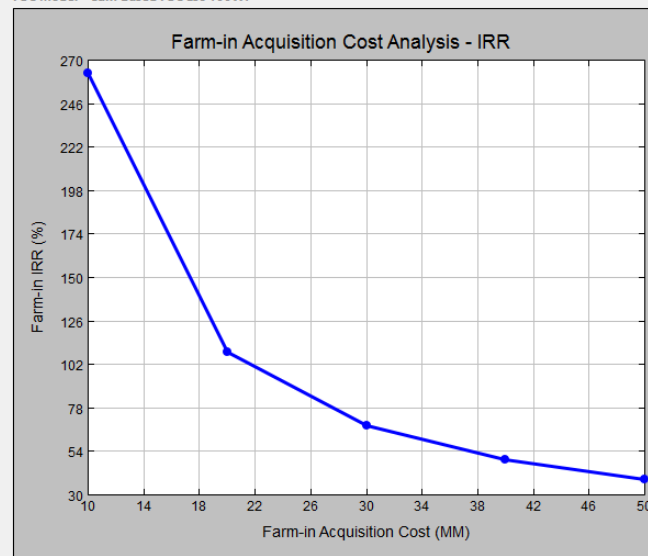
Import Acquisition Costs

Save Acquisition Costs to PE Tools db

Open PE dB

Continue

PSC Model - Cum Based PSC Esc 100WI



Run Acquisition Analysis

☐ Plot NPV ☒ Plot IRR

Equity Purchase (%) 10

Sensitivity: Acquisition Costs

of Acquisition Costs 5

#	Acquisition Cost
1	10
2	20
3	30
4	40
5	50

Save Results to Spreadsheet

Import Acquisition Costs

Save Acquisition Costs to PE Tools db

Open PE dB

Continue

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**Tools and Techniques to Evaluate Unconventional (and
Conventional) Wells and Reservoirs**

Version 2024