

GOMFields Help

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GOMFields

US Federal Offshore Gulf of Mexico Oil and Gas Field Production Analysis Software

by Petroleum Solutions Ltd

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GOMFields

US Federal Offshore Gulf of Mexico Oil and Gas Field Production Analysis Software



1 Welcome to GOMFields

1.1 Introduction



GOMFields is a production analysis database containing all the US Federal Offshore Gulf of Mexico oil and gas producing fields monthly production data to December 2009. The intent of this application is to periodically re-publish the database once the data becomes available.

Through the use of this application, the user can quickly :

- Analyse the production history of any field in the Gulf of Mexico, based on a rate or ratio vs time basis or rate or ratio vs cumulative basis, for all available data to December 2009.
- Export the field production histories of any field to any external package via copy and paste and the windows clipboard.
- Display presentation quality charts of field production histories, and export any of the charts within the application via the clipboard or by saving as JPG / PNG / etc.
- Obtain well statistics [maximum rates, cumulative recoveries, etc] on a fieldby-field basis, for all available data from January 1996 to December 2009.
- Perform field level decline curve analysis on the oil or gas rate vs time basis, or any rates and ratios displayed on a cumulative basis.

Examine the key production profile statistics for any UK oil and gas field for analogue field comparison. Figures are calculated for peak offtake rate, cumulative offtake, decline curve parameters, associated hydrocarbon (gas or condensate) and non-hydrocarbon (water) development with time and versus cumulative hydrocarbon phase.

Contrast the production performance for similar fields to enable field acquisition analysis, and future potential production and reserves optimisation.

License.dat File

The "License.dat" file is located in the Application Startup folder (eg C:\Program Files\Petroleum Solutions\GOMFields\)

The contents of this ASCII license file needs to contain the following license information.

[License Settings] LicensedTO = Company = ProductID = LicenseID =

If any of the above License key information is incorrect or absent, or if the License.dat file is missing then the application will fail to startup.

.NET Framework

This application requires the presence or installation of Microsoft .Net Framework version 2.

.NET Framework version 2 is a component of the Microsoft Windows® operating system used to build and run Windows-based applications.

Should .NET Framework version 2 not be installed on the destination PC then a link is provided below to download this system software. The user should download and install .NET Framework version 2 before attempting to install this application.

Inttp://www.petroleumsolutions.co.uk/downloads.html

The installation of .Net Framework also requires a minimum software and hardware requirement. Details of which are shown below. Specifically, note that you cannot install the .NET Framework on a computer running the Microsoft Windows 95 operating system.

Minimum requirements

To install .NET Framework [Dotnetfx2.exe], you must have one of the following operating systems, with Microsoft Internet Explorer 5.01 or later installed on your computer:

Microsoft® Windows® 98

- Microsoft® Windows® 98 Second Edition
- Microsoft® Windows® Millennium Edition (Windows Me)
- Microsoft® Windows NT® 4 (Workstation or Server) with Service Pack 6a
- Microsoft® Windows® 2000 (Professional, Server, or Advanced Server) with the latest Windows service pack and critical updates available from the Microsoft Security Web site (www.microsoft. com/security).
- Microsoft® Windows® XP (Home or Professional)

Recommended hardware

CPU Recommended	RAM Recommended
Pentium 90 MHz or faster	96 MB or higher

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2 Application Options

2.1 Chart Display Options

Any part of the chart displays can be changed to suit specific user preferences. These options can be accessed by selecting the Application Options button on the bottom left corner of the application, as highlighted below.

By scrolling up and down within this Application Options property grid and selecting the various options, the user can change any part of the Chart Appearance.



2.2 Treeview Navigation

Selecting an oil or gas field for analysis could not be easier, and is done with the Fields Tree View panel. To select a field simply single right mouse click on the field name within the Field View panel, as shown below.



The user can choose to sort the FieldView docking panel, either alphabetically or by Gulf of Mexico Planning Area. The selection between these two options is also highlighted below.



The user can also choose to auto Hide the Panel by selecting the Arrows icon, as shown below. Once selected the Panel should collapse, as shown below. To recover the Fields Tree View Panel just select the Arrows icon again.



2.3 Units

The database application units are stored in metric units, however within the application the user can choose to work in either Metric or, more commonly, Oilfield units.

To switch between units, simply select the Oilfield Units or Metric Units menu item as shown below.



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US Federal Offshore Gulf of Mexico Oil and Gas Field Production Analysis Software



3 Field Details

3.1 Overview and Field History Data

Once the application launches successfully, the following should be displayed.

											- S
Free View	K Field Details	Time Analysis	Cumulative Analys	sis Predictions							
GA418	^		CD420 Augus		D 101		0.0		C07402 Array CD	Dia - 1.: 427	
- GA427	Field N	lame	GB426, Auger		Proved Oil [(Mstb) 22	9.0		Lease: G07493 Area: GB Lease: G07498 Area: GB	Jock: 427 Block: 471	
- GA460 - GA465	Operator Fi	eld Name	Auger		Proved Gas	[BCF] 819	9.4		Lease: G08241 Area: GB	llock: 426	
Garden Banks	D-H-S		-		1				Lease: G08248 Area: GB	lock: 4/0	
GB065	Field	ype	0ii		Water Dep	th [ft] 2.8	60.0				
🗣 GB070, Seastar	Discover	y Date	1987		Field COP #	of (ath) 35	79				
 GB072, Spectacular Bid 	1				I Heu GON (s	ci/subj 55	13				
GB083, Enchilada/Elmer											
GB108 GB129	Field History	Well History									
GB133 GB142 Matia	Month	Oil Rate	Gas Rate	Water Rate	Liquid Rate	Oil Volume	Gas Volume	Water Volume	e Liquid Volume	Cumulative	Cumula
GB161, Spend A Buck	Month	[bbls/d]	[Mcf/d]	[bbls/d]	[bbls/d]	[bbls]	[Mcf]	[bbls]	[bbls]	Oil [bbls]	Gas [M
GB171, Salsa	Apr-1994	963	.2 1,875.1	5.9	969.1	28,895	5.0 56,254.0	1	78.0 29,073.0	28,895.0	5
🔶 GB179	May-1994	3,293	.5 6,968.1	0.0	3,293.5	102,100	0.0 216,010.0)	0.0 102,100.0	130,995.0	27.
🗣 GB184	Jun-1994	12,087	.1 36,274.2	12.1	12,099.2	362,613	3.0 1,088,226.0) 31	62.0 362,975.0	493,608.0	1,36
GB186, Cabrito	Jul-1994	24,103	.3 72,973.0	23.5	24,126.8	747,202	2.0 2,262,162.0) 7:	30.0 747,932.0	1,240,810.0	3,62
 GB189, Tick 	Aug-1994	41,794	.1 97,725.3	3.6	41,797.7	1,295,617	7.0 3,029,484.0) 1	13.0 1,295,730.0	2,536,427.0	6,65
GB195	Sep-1994	45,399	.1 99,914.4	1.1	45,400.2	1,361,972	2.0 2,997,431.0) :	33.0 1,362,005.0	3,898,399.0	9,64
GB197	Oct-1994	41,467	.7 87,605.5	0.1	41,467.9	1,285,500	2,715,769.0)	4.0 1,285,504.0	5,183,899.0	12,36
GB200, Northwestern	Nov-1994	37,893	.3 79,656.5	3.1	37,896.4	1,136,800	2,389,696.0) !	93.0 1,136,893.0	6,320,699.0	14,75
GB203	Dec-1994	47,107	./ 101,054.2	0.0	47,107.7	1,460,338	3,132,6/9.0)	0.0 1,460,338.0	/,/81,03/.0	17,88
GB224 Santa Fe	Jan-1995	31,118	.8 64,706.5	0.0	31,118.8	964,684	4.0 2,005,902.0)	0.0 964,684.0	8,/45,/21.0	19,89
GB236. Pimento	Feb-1995	48,227	.8 102,033.1	0.0	48,227.8	1,350,378	3.0 2,856,928.0)	0.0 1,350,378.0	10,096,099.0	22,75
GB240, Mustique	Mar-1995	49,056	.0 102,4/9.3	286.5	49,342.5	1,520,730	3,1/6,858.0	8,8	82.0 1,529,618.0	11,616,835.0	25,92
 GB260, Baldpate 	Apr- 1995	45,807	7 100 500 0	6.9	45,814.1	1,3/4,214	4.0 2,851,227.0	2	0.0 1,3/4,422.0	12,991,049.0	28,77
GB302, Gb302	May-1995	58,746	7 122,062.2	0.0	56,746.7	1,821,147	7.0 3,799,429.0)	0.0 1,821,147.0	14,812,196.0	32,57
GB367, Dulcimer	Jun-1995	55,220	1 110,085.3	0.0	56,220.7	1,000,02	3,512,558.0)	0.0 1,686,621.0	16,498,817.0	36,09
🗣 GB379	JUI-1995	57,113	0 110,420.6	0.0	57,113.1	1,770,500	3,702,038.0)	0.0 1,770,506.0	10,269,323.0	33,73
GB387, Llano	Sep 1995	40 710	7 04 000 0	0.0	40 710 9	1 221 221	1.0 2,520,267 (, ,	5.0 1,733,427.0	20,002,750.0	45,40
GB388, Cooper	Oct 1995	40,710 52,422	1 114 725 9	0.2	40,710.3 52,422.1	1,221,32	2,520,267.0	,	0.0 1,221,320.0	21,224,071.0	40,50
GB409, Ladybug	Nov 1995	59,452	5 127 120 5	0.0	59,452.1	1 794 02/	0 2 014 155 (,	0.0 1,000,000.0	22,000,407.0	40,04 62.25
GR516 Serrano	Dec-1995	CE 002	9 1/2 695 7	2.2	CE 905 1	2.045.469	4.0 4.454.259.0	,	70.0 2.045.529.0	24,004,401.0	57,01
▲ GB559 Oregano	Jan-1996	69,000	9 150 618 5	0.0	6 380 63	2 141 695	5.0 4,669,173,0	, ,	0.0 2 141 695 0	28,851,655,0	62.48
GB602, Macaroni	Feb-1996	69 547	1 150,033,3	0.0	69 547 1	2 016 867	7.0 4 350 966 0)	0.0 2,016,867 (30,868,522,0	66.83
GB668, Gunnison	Mar-1996	68 591	7 148 098 6	0.0	68 591 7	2 126 343	4,550,000,000,000,000,000,000,000,000,00	,)	0.0 2,126,343.0	32 994 865 0	71.42
 GB783, Magnolia 	Apr-1996	46 017	8 103 832 6	13	46 019 1	1 380 535	50 3 114 979 0)	38.0 1.380.573.0	34 375 400 0	74 53
GB877, Red Hawk	May-1996	70 652	9 165 464 5	0.0	70,652,9	2 190 239	5 129 401 0)	0.0 2 190 239 0	36 565 639 0	79.66
High Island	Jun-1996	69,666	9 163,218,4	0.0	69,666,9	2,090,000	4,896,551.0)	0.0 2.090.006.0	38,655,645,0	84.56
HI006A	Jul-1996	67.967	7 159.339.8	0.0	67,967,7	2.107.000	4,939,535.0)	0.0 2.107.000.0	40,762,645,0	89.50
HI009A	Aug-1996	63,495	4 152,405.1	0.0	63,495.4	1,968,356	6.0 4,724,557.0)	0.0 1,968,356.0	42,731,001.0	94,22
HIU14A	Sep-1996	69,966	9 168,937.7	0.0	69,966.9	2,099,008	5,068,131.0)	0.0 2,099,008.0	44,830,009.0	99,29
HIUZUA	Oct-1996	62,619	3 149,552.7	0.0	62,619.3	1,941,198	4,636,133.0)	0.0 1,941,198.0	46,771,207.0	103,93
	Nov-1996	68,368	8 160,685.6	0.0	68,368.8	2,051,063	4,820,567.0)	0.0 2,051,063.0	48,822,270.0	108,75

Copy and Paste Datatable Information to External Applications

Any of the table data can be copied as pasted into external applications via two methods.

1. Either press the right mouse button once over any of the tables to activate the table context menu, as highlighted below, then select the various menu item to copy a specific table to the clipboard.

Month 🖌	Oil Rate [bbls/d]	Gas Rate [Mcf/d]	Water Rate [bbls/d]	Liqu (b	uid Rate bls/d]
Oct-1978	7,761	.8 5,137.7	0.0		7,761.8
Nov-1978	12 010	0 000 0	0.0		13,819.8
Dec-1978		Copy Field Table	to clipboard	N	12,635.8
Jan-1979				5	16,777.6
Feb-1979	1	Copy Well Table t	o clipboard		15,530.4
Mar-1979		Conv Bradiction T	able to clipboard		14,162.0
Apr-1979	4	Copy Prediction 1	able to clipboard		14,035.7
May-1979	23,556	.8 15,731.0	0.0		23,556.8
lun-1979	21 292	9 1/1 2/1/1 8	0.0		21 392 9

2. Or, simply select and drag an area with the mouse, then press the standard windows CTRL+C keys to copy the selected area to the clipboard.

Month 🖌	Oil Rate [bbls/d]	Gas Rate [Mcf/d]	Water Rate [bbls/d]	Liquid Rate [bbls/d]
Oct-1978	7,761.8	5,137.7	0.0	7,761.8
Nov-1978	13,819.8	9,062.9	0.0	13,819.8
Dec-1978	12,635.8	8,108.7	0.0	12,635.8
Jan-1979	16,777.6	11,338.3	0.0	16,777.6
Feb-1979	15,530.4	10,323.2	0.0	15,530.4
Mar-1979	14,162.0	9,254.7	0.0	14,162.0
Apr-1979	14,035.7	9,054.7	0.0	14,035.7
May-1979	23,556.8	15,731.0	0.0	23,556.8
Jun-1979	21,392.9	14,304.8	0.0	21,392.9
Jul-1979	17,887.8	11,887.4	0.0	17,887.8
Aug-1979	20,433.0	13,089.2	0.0	20,433.0
Sep-1979	18,391.8	11,496.1	0.0	18,391.8
Oct-1979	15,646.8	9,356.1	0.0	15,646.8
Nov-1979	13,801.5	8,824.0	0.0	13,801.5
Dec-1979	13,385.5	8,412.9	0.0	13,385.5
Jan-1980	14,338.7	8,631.6	0.0	14,338.7
Feb-1980	13,525.0	7,350.3	3.0	13,525.0
1000	11 000 0	0.404.0	0.0	11 000 0

3.2 Well History Data

Summary well data has also been incorporated into the database. Based on published well data from January 1996 to December 2009, individual wells have been summarised in the database and presented by field in the formats presented below. From this data, the user can approximately determine the range of peak production rates and likely well cumulative production volumes for any field with data to December 2009.

Field Nan	ne	GB426,	Auger	F	Proved Oil [MMstb]	229.0)		Lease: G07493 Area Lease: G07498 Area	: GB Block: 427 : GB Block: 471	
Operator Field	Name	Auger			Proved Gas [BCF]	819.4	ł		Lease: G08241 Area	GB Block: 426	
Field Typ	e	Oil			Water Depth [ft]	2,860).0				
Discovery I	Date	1987		F	ield GOR [scf/stb]	3579					
				I					,		
Field History W	ell Histor	У									
WellName	Month Produ	hs on action	Max Oil Rate [bbls/d]	Max Gas Rate [Mcf/d]	Max Water [bbls/d]	Rate	Cumulative Oil [bbls]	Cumulative Gas [Mcf]	Cumulative Water [bbls]		
A001		102	9,011.3	26,36	8.4 1	4,232.3	10,904,483.0	23,521,123.	2,230,306.0		
A002		78	11,576.9	35,86	9.9	5,775.8	10,080,215.0	24,844,069.	1,906,274.0		
A003		102	13,950.1	59,88	4.8	8,792.2	4,965,478.0	23,343,233.	1,537,601.0		
A004		29	11,940.8	20,14	4.8	1,996.5	5,495,213.0	9,183,424.	302,924.0		
A005		104	9,528.6	24,44	3.1	3,248.2	9,380,834.0	20,517,573.	2,273,627.0		
4006		38	11,533.8	22,43	1.8	3,668.4	8,056,688.0	14,165,364.	335,795.0		
A007		63	10,804.9	18,14	1.2	4,821.1	8,973,023.0	15,513,169.	1,879,691.0		
A008		106	13,118.6	88,20	2.9	4,636.8	20,132,184.0	122,808,330.	1,365,711.0		
A009		79	16,897.0	30,80	1.0	6,836.7	14,035,123.0	31,118,233.	3,409,403.0		
A010		84	14,375.4	84,86	0.9 1	0,146.7	8,714,639.0	54,910,301.	5,332,780.0		
4011		63	3,685.7	32,10	4.3	4,579.9	1,209,790.0	8,015,484.	3,144,460.0		
4012		114	12,688.4	44,50	5.3	7,538.7	12,932,695.0	33,317,571.	10,633,990.0		
A013		111	19,459.3	44,73	1.6	3,109.5	15,753,699.0	43,750,113.	3,915,002.0		
A014		130	12,589.8	66,26	6.6	4,075.4	18,178,065.0	91,943,981.	3,700,236.0		
A015		69	7,008.9	28,43	2.5	2,718.5	6,984,883.0	26,523,542.	569,948.0		
A016		86	13,522.5	68,64	8.4	3,657.3	12,479,178.0	58,464,870.	1,704,837.0		
A017		10	18,052.7	35,11	8.3	0.0	4,390,660.0	8,799,724.	0.0		
4018		36	5,556.7	47,42	4.3	3,133.4	1,505,745.0	15,291,601.	722,828.0		
A019		81	9,839.3	32,41	5.9	4,001.2	13,749,731.0	45,914,291.	1,597,350.0		
A020		102	12,554.5	87,49	3.5	9,382.3	9,576,318.0	79,404,400.	4,333,329.0		
linimum			3,685.7	18,14	1.2						
Average			11,884.8	44,91	4.5						
Maximum			19,459.3	88,20	2.9						

Again, the user can copy and paste the datatable information to any external package via the two methods discussed in the previous section.

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US Federal Offshore Gulf of Mexico Oil and Gas Field Production Analysis Software



4 Time Analysis

4.1 Oil Production

Within the Time Analysis section, the user can display numerous production and injection rates and ratios versus time.

The user can also perform decline curve analysis on both the Oil and Gas production rate, for exponential, harmonic and hyperbolic decline curve equations.



The user can choose between linear and logarithmic Y axis display by selecting the chart context menu with a single right mouse click. See screen capture provided below.



Many other production ratios are provided as a secondary Y axis display, to help in the field production profile and decline curve selection. These can be changed again via the chart context menu as shown below.



The user can also choose to display the secondary Y axis as either linear or logarithmic. See screen capture provided below.



Regress Decline Exponents

To select points for decline curve analysis, first select the Regress Decline Exponents then Select Points menu item, as shown below.



Once the user has selected 2 points a message box will pop up acknowledging the fact that 2 points were digitized. The user can them choose to fit a decline type, either Exponential, Harmonic or Hyperbolic.



Examples of each decline type are shown below.

Decline Fit	Decline Fit
O Exponential Decline	O Exponential Decline
• Harmonic Decline	O Harmonic Decline
O Hyperbolic Decline	• Hyperbolic Decline
Initial Production Rate 33986.9	Initial Production Rate 33986.9
Final Production Rate 10827.4	Final Production Rate 10827.4
Cumulative Production 4134146.0	Cumulative Production 4134146.0
Time [days] 242.0	Time [days] 242.0
Fit Decline Rate	Fit Decline Rate
Select root 🗸 🗸	Select root Root 3
a 0.008839/day 3.228344/year	a 0.013482 Root 1 0.013482 Root 2 Root 3 1.596104
	Decline Fit

Where,

• a = Constant decline rate fraction, between 0 and 1

• n = additional hyperbolic constant decline exponent, typically between 0 and 1

Special cases for the hyperbolic decline equation occur at n=0 [exponential decline] and n=1 [harmonic decline].

The following text is taken from "Petroleum Engineering Handbook" published by the Society of Petroleum Engineers, page 40-26. "An analysis of a large number of actual production-decline curves assembled by Cutler indicates that most decline curves normally encountered are of the hyperbolic type, with values for the exponent n between 0 and 0.7, while the majority fall between 0 and 0.4."

For both the exponential and harmonic decline curves, the exponent 'a' can be solved by re- arranging their decline curve equations to the following :



The solution of the hyperbolic parameters are based on the technique described in the following Society of Petroleum Engineers paper, where an additional parameter Cumulative production, Np, is required.

"A Numerical Solution to Two-Parameter Representation of Production Decline Curve Analysis", SPE16505, B. Agbi and M Ng, 1987

The solution of the hyperbolic decline curve equation for values of 'a' and 'n' displays all roots of the equation, including values of 'a' at n=0 (exponential decline) and n=1 (harmonic decline). Typically, the value of 'n' at Root 2 is between 0 and 1.

Once the user has selected the Decline Type and pressed the **Fit Decline Rate** button, they can then approximately calculate the likely Ultimate Recovery at abandonment and Abandonment date. Should the user want a more accurate prediction of the Ultimate Recovery at abandonment and Abandonment date, then they should use



For completeness, the equations used to calculate these Ultimate Recoveries and abandonment dates are provided below, where qi is the first digitized point and the Initial Production Rate.

Exponential Decline Ultimate Recovery Equation Abandonment Time Equation $N_{pa} = \frac{1}{a} \times (q_i - q_a)$ $T_a = \frac{ln\left(\frac{q_a}{q_i}\right)}{-a}$

Harmonic Decline Ultimate Recovery Equation Abandonment Time Equation

$$N_{pa} = \frac{q_i}{a} \times \ln\left(\frac{q_i}{q_a}\right) \qquad T_a = \frac{\left(\frac{q_a}{q_i} - 1\right)}{a}$$

Hyperbolic Decline Ultimate Recovery Equation Abandonment Time Equation



Assuming a decline curve analysis has been performed on the Oil Production Rate, the user should press the **Save Time Forecast** button to ensure that the digitized points, decline and prediction parameters are saved.

Offtake Rates, Formation Volume Factors and Chart Tooltips

Once the user has determined the likely Ultimate field Recovery based either on the Rate vs Time analysis or any of the Rate or Ratio vs Cumulative analysis, then they can choose to input this figure into the Ultimate Recovery input box, as shown below.

Also, should the user calculate a more accurate Cumulative Voidage Replacement, they can input values for produced Oil and Water formation volume factors as shown below. Once the user presses the **Save Time Forecast** button, as shown below, the calculation of Cumulative Voidage Replacement is updated and can be displayed in the Y2 axis by selecting Set Y2 Axis = Cumulative Voidage chart context menu item.

Field Name		Field Name				
GB426, Auger		GB426, Auger				
Ultimate Recovery [mmstb]	225	Ultimate Recovery [mmstb] 225				
	ß					
Decline Fit		Decline Fit				
 Exponential Decline 		 Exponential Decline 				
O Harmonic Decline		O Harmonic Decline				
O Hyperbolic Decline		O Hyperbolic Decline				
Initial Production Rate 263	66.8	Initial Production Rate 26366.8				
Final Production Rate 123	00.9	Final Production Rate 12300.9				
Cumulative Production 358	4831.0	Cumulative Production 3584831.0				
Time [days] 242	.0	Time [days] 242.0				
Fit Decline Rate]	Fit Decline Rate				
Select root	~	Select root				
a 0.004725/day 1.72586	0/year	a 0.004725/day 1.725860/year				
n	-					
Prediction		Prediction				
Qi Use decline t	rend 🔽	Qi Use decline trend 💙				
Qa 1000		Qa 1000				
Predict]	Predict				
Npa 225,633,018.	7	Npa 225,633,018.7				
Та		Та				
Save Time Forecas	t	Save Time Forecast				

Once the Ultimate Recovery figure has been input into the text box, the user should press the **Save Time Forecast** button, as shown above. This will then enable the calculation of monthly, annual and cumulative offtake rates, which are displayed in the form of chart tooltips. See below.



Zooming and Unzooming within a Chart Area

Zooming within the chart area also couldn't be easier. Just single left-mouse click and drag the area of interest for zooming, as shown below.



To unzoom simply single left mouse click one of the unzoom icons provided at the extremes of the axes scroll bars, as shown below.



4.2 Gas Production

All of the same functionality that was presented in the Oil Production section is also available for Gas Production analysis, including decline curve analysis, chart tooltips, ultimate recovery and abandonment prediction.

Two specific examples are provided below, although the equations and methods are identical to the Oil Production section.





Assuming a decline curve analysis has been performed on the Gas Production Rate, the user should

press the **Save Time Forecast** button to ensure that the digitized points, decline and prediction parameters are saved.

4.3 Water Production

Water Production rate versus time is displayed as the primary Y axis in this display.

No decline curve analysis can be performed while within this display. All other chart functionality that was presented in the Oil Production Time Analysis section is available.



4.4 Liquid Production

Liquid Production (Oil + Condensate + Water) rate versus time is displayed as the primary Y axis in this display.

No decline curve analysis can be performed while within this display. All other chart functionality that was presented in the Oil Production Time Analysis section is available.



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5 Cumulative Analysis

5.1 Oil Rate

Within the Cumulative Analysis section, the user can display numerous production and injection rates and ratios versus Cumulative Production.

The user can also perform linear or semi-logarithmic decline curve analysis for Oil Rate, Gas Rate, Oilcut, Watercut and Water Oil Ratio versus Cumulative Production.



Regress Decline Exponents

The method to regress decline exponents is identical to the Oil and Gas Rate versus Time Analysis, presented is earlier sections.

First select the Regress Decline Exponents then Select Points chart context menu item, as shown below. Then digitize two points on the chart



Once the user has selected two points, a message box will popup notifying the user that 2 points have been selected. The application will automatically fit a straight line between these 2 digitized points, and report the gradient and intercept of this line, as shown below.

The user can choose to fit a semi logarithmic straight line, by selecting the Regress Log Y Values check box, also shown below, assuming this is checked then the application will automatically update the fit, and report the revised gradient and intercept of this line.



The user can also calculate an approximate Ultimate Recovery, by selecting between using the decline trend or last production value and inputting a final abandonment production value. The user should then press the **Predict** button, as shown above, to extrapolate the line to the abandonment value. See calculated result below.

Oil Rate	
Regres	s Log Y Values
Gradient	-0.003441855809
Y Intercept	736643.0068103130
X Intercept	214,024,947
Predi	iction Setup
Initial value	Use last value 🛛 🗸
Final value	5000
F	Predict
Npa	219,247,361.1

5.2 Gas Rate

Again, all of the same functionality that was presented in the Oil Production v's Cumulative analysis section is also available for Gas Production analysis, including decline curve analysis, chart tooltips, and ultimate recovery at abandonment prediction.



Two specific examples are provided below, although the equations and methods are identical to the Oil Production section.



5.3 Oilcut, Watercut and Water Oil Ratio

Again, all of the same functionality that was presented in the Oil Production Vs Cumulative analysis section is also available for either Oilcut, Watercut or Water Oil Ratio versus Cumulative Production analysis, including decline curve analysis, chart tooltips, and ultimate recovery at abandonment prediction.

Specific examples are provided for completeness below, although the equations and methods are identical to the Oil Production section.



Regress Decline Exponents

The method to regress decline exponents is identical to the Oil and Gas Rate versus Cumulative Analysis, presented is earlier sections.

First select the Regress Decline Exponents then Select Points chart context menu item, as shown below. Then digitize two points on the chart



Once the user has selected two points, a message box will popup notifying the user that 2 points have been selected. The application will automatically fit a straight line between these 2 digitized points, and report the gradient and intercept of this line, as shown below.

The user can choose to fit a semi logarithmic straight line, by selecting the Regress Log Y Values check box, also shown below, assuming this is checked then the application will automatically update the fit, and report the revised gradient and intercept of this line.



The user can also calculate an approximate Ultimate Recovery, by selecting between using the decline trend or last production value and inputting a final abandonment production value. The user should then press the **Predict** button, as shown above, to extrapolate the line to the abandonment value. See calculated result below.

Fiel	ld Name
MC58	2, Medusa
Oilcut	
Regres	s Log Y Values
Gradient	-0.00000016851
Y Intercept	1.0903030810
X Intercept	64,702,043
Predi	iction Setup
Initial value	Use last value 🔽
Final value	0.05
F	Predict
Npa	62,344,448.9
Watercut versu	IS Np/N Chart
STOIIP [MMs	tb]
Recovery Facto	or [%]
Abandon't fw	[%]
Customise C	Curvature
Early Cur	rvature 1 🕂
Late Cur	vature 1 🛨
Save	e Forecast

5.4 Watercut v's Np/N

The Watercut versus Np/N chart can be seen as a measure of the waterdrive efficiency of a specific oil field, which is typically linked to the degree of vertical permeability heterogeneity and the oil / water viscosity contrast. The chart requires additional estimated values for original in-place volumes (STOIIP), a likely abandonment ultimate recovery factor and an abandonment watercut. See below.

This chart can also be used as a data source for our other application *Profile*, which is a generic Production Profile Generation and Analysis application. See our homepage for more details www. PetroleumSolutions.co.uk.



Once these 3 additional values have been input the user can start to iterate values for early and late watercut curvature.



Negative values of early curvature generally translate to a delayed water production breakthough,

potentially implying good piston-like waterdrive efficiency. Highly positive of early curvature translate in rapid water breakthrough, potentially implying an adverse or poor waterdrive application, with likely high permeability streaks and/or high oil / water viscosity contrast. This situation will likely create poor vertical and/or areal sweep efficiency and create a high potential for bypassed oil.



Negative values of late curvature generally translate to a longer period of high water "tail" production, that asymptotes slowly towards the abandonment recovery factor and watercut levels. A positive value for late curvature, when combined with a negative value for early curvature is typically the best character for a waterdrive displacement process, and implies a delayed water breakthrough followed by a rapid watercut development to the likely high value of ultimate recovery factor. This is the ideal piston-like waterflood displacement process.

Should the user wish to save this match of watercut v/s Np/N, they should simply select the **Save** Forecast button, as shown below.

Field	d Nar	ne
VK956, F	Ram-	Powell
Oil Rate		
Regress	Log	Y Values
Gradient		
Y Intercept		
X Intercept		
Predic	ction	Setup
Initial value	Use d	lecline trend ∨
Final value		
P	redict	
Npa		
Watercut versus	s Np/	N Chart
STOIIP [MMst	b]	220
Recovery Facto	r [%]	45
Abandon't fw [%]	60
Customise Cu	urvatu	re
Early Curv	vature	4 ÷
Late Curv	ature	-9 🕂
Save	Fore	cast
		<i>.a</i>

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6 Predictions

For all the decline curves that were saved during the Time Analysis and Cumulative Analysis sections, the user now has the ability to forecast on a monthly basis the likely future oil, gas, water and liquid production profiles.

For the Oil and Gas rate versus time, the prediction setup is simple and is highlighted at the top of the screen capture below. The uses the calculated and saved decline curve parameters and the user can change whether to forecast from the decline trend or use the last historical production rate; the user should also input the final abandonment prediction rate. Once the user presses the **Calculate Predictions** button, the application will simply progress monthly using the decline curve and prediction parameters until the abandonment production level is reached

For Oil and Gas rate versus Cumulative Production, the application progresses from month to month using the gradient and intercept relationship together with Newton-Raphson iteration to ensure that the monthly extrapolated production rates follow the original decline parameters.

The oilcut, watercut and water-oil ratio prediction methods use a similar extrapolation technique to the oil and gas rate versus cumulative production, however need to be linked to an oil production rate forecast or assume a constant liquid rate in order to convert these forecasts to time. As such the application provides three methods to generate this time forecast; namely

- 1. Link to Oil Rate Vs Time Prediction
- 2. Link to Oil Rate ∨ Cumulative Prediction
- 3. Input Constant Llquid Rate Value

Examples of these options are highlighted below.

d	Details 1	Time Analysis Cun	nulative Analysis P	redictions		
edi	ictions Setup	Prediction Charts	Prediction Table	is		
ate	e v's Time Pro	ediction Setup				
		Oil	Gas			
	Decline	Exponential 💌	Exponential 🗸			
	'a' value	0.00070796372014				
	'n' value					
	Final Rate	Use decline trend	Use decline trend			
un	nulative Pred	iction Setup				
		Oil	Gas	Oilcut	Watercut	Water Oil Ratio
h	Log Y Fit ?	No No	🗌 No	No No	No No	No No
	Gradient	-0.0006234471116		-2.9438519959740		
	Y Intercept	59694.524341609(2.7493389709057		
1	Initial value	~	~	~	×	~
	Final value	0	0	0	0	0
		Con	vert to Time Options	Link to Oil Rate v's Tim	ne Prediction	~
			Input Liquid Rate			

Once the user has successfully input all the appropriate data for a time forecast to be calculated and pressed the **Calculate Predictions** button, as shown above, then the Prediction Charts tab should contain an active chart with the predictions displayed.



The user can zoom in and scroll around the chart area to examine and compare the range of time forecasts calculated.



Assuming an oilcut, watercut or water oil ratio forecast was successfully calculated then the user can switch to the water production rate prediction chart, as shown below, and again choose to zoom in the examine these forecasts.



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All of the forecasts that were calculated are reported in the Prediction Tables tab. The user can copy and paste the data from this table to external applications, via the two methods discussed below.

- 1. Either press the right mouse button once over any of the tables to activate the table context menu, as highlighted below, then select the various menu item to copy a specific table to the clipboard. See screen capture example below.
- 2. Or, simply select and drag an area with the mouse, then press the standard windows CTRL+C keys to copy the selected area to the clipboard.

Month	Oilrate Time Oil Rate [bbls/d]	Oilrate Time Cumulative Oil [bbls]	Month	Oilrate Cumulative Oil Rate [bbls/d]	Oilrate Cumulative Cumulative Oil [bbls]	Month	Oilcut Cumulative Oil Rate [bbls/d]	Oilcut Cumulative Cumulative Oil [bbls]	Oilcut Cumulative Water Rate [bbls/d]	Oil
Oct-2007	8,111.7	82,738,128.0	Oct-2007	8,111.7	82,738,128.0	Oct-2007	8,111.7	82,738,128.0	2,206.5	
Nov-2007	7,935.6	82,992,066.9	Nov-2007	7,953.0	82,992,624.4	Nov-2007	7,935.6	82,992,066.9	2,255.5	
Dec-2007	7,7	Conv Field Table 6	a aliaba and	7,802.2	83,234,493.2	Dec-2007	7,768.8	83,232,900.5	2,299.8	
Jan-2008	7,6	Copy Field Table 0	ocipboard	7,649.6	83,479,280.7	Jan-2008	7,600.2	83,476,106.3	2,342.1	
Feb-2008	7,4 🗋	Copy Well Table to	clipboard	7,500.0	83,719,280.1	Feb-2008	7,435.2	83,714,032.6	2,381.2	
Mar-2008	7,2	Copy Prediction Ta	ble to clipboard	7,362.3	83,940,148.5	Mar-2008	7,284.1	83,932,555.6	2,415.2	
Apr-2008	7,120.0	04,100,307.0	APJ-2000	7,218.3	84,171,133.3	Apr-2008	7,126.0	84,160,587.0	2,448.3	
May-2008	6,976.2	84,376,850.1	May-2008	7,081.4	84,390,657.1	May-2008	6,976.2	84,376,850.1	2,477.8	
Jun-2008	6,824.8	84,595,243.4	Jun-2008	6,942.9	84,612,829.9	Jun-2008	6,824.8	84,595,243.4	2,505.3	
Jul-2008	6,681.4	84,802,365.7	Jul-2008	6,811.3	84,823,978.9	Jul-2008	6,681.4	84,802,365.7	2,529.4	
Aug-2008	6,536.3	85,011,528.3	Aug-2008	6,678.0	85,037,675.9	Aug-2008	6,536.3	85,011,528.3	2,551.6	
ep-2008	6,394.4	85,216,150.4	Sep-2008	6,547.4	85,247,193.0	Sep-2008	6,394.4	85,216,150.4	2,571.3	
ct-2008	6,260.1	85,410,212.3	Oct-2008	6,423.3	85,446,314.2	Oct-2008	6,260.1	85,410,212.3	2,588.2	
lov-2008	6,124.2	85,606,185.7	Nov-2008	6,297.6	85,647,838.3	Nov-2008	6,124.2	85,606,185.7	2,603.2	
ec-2008	5,995.5	85,792,045.2	Dec-2008	6,178.2	85,839,363.2	Dec-2008	5,995.5	85,792,045.2	2,615.6	
an-2009	5,865.3	85,979,735.5	Jan-2009	6,057.4	86,033,199.2	Jan-2009	5,865.3	85,979,735.5	2,626.2	
eb-2009	5,738.0	86,163,351.5	Feb-2009	5,938.9	86,223,243.7	Feb-2009	5,738.0	86,163,351.5	2,634.7	
/ar-2009	5,625.4	86,326,487.3	Mar-2009	5,833.4	86,392,413.0	Mar-2009	5,625.4	86,326,487.3	2,640.9	
pr-2009	5,503.3	86,502,591.6	Apr-2009	5,719.3	86,575,431.3	Apr-2009	5,503.3	86,502,591.6	2,645.7	
/ay-2009	5,387.6	86,669,607.5	May-2009	5,610.9	86,749,368.6	May-2009	5,387.6	86,669,607.5	2,648.6	
un-2009	5,270.7	86,838,268.5	Jun-2009	5,501.1	86,925,404.8	Jun-2009	5,270.7	86,838,268.5	2,649.7	
ul-2009	5,159.9	86,998,225.2	Jul-2009	5,396.8	87,092,706.5	Jul-2009	5,159.9	86,998,225.2	2,649.3	
ug-2009	5,047.9	87,159,757.4	Aug-2009	5,291.3	87,262,027.0	Aug-2009	5,047.9	87,159,757.4	2,647.2	
ep-2009	4,938.3	87,317,783.2	Sep-2009	5,187.8	87,428,035.6	Sep-2009	4,938.3	87,317,783.2	2,643.5	
ct-2009	4,834.5	87,467,653.5	Oct-2009	5,089.4	87,585,807.2	Oct-2009	4,834.5	87,467,653.5	2,638.6	
lov-2009	4,729.6	87,619,000.0	Nov-2009	4,989.9	87,745,482.6	Nov-2009	4,729.6	87,619,000.0	2,632.0	
ec-2009	4,630.2	87,762,535.9	Dec-2009	4,895.2	87,897,235.2	Dec-2009	4,630.2	87,762,535.9	2,624.4	
an-2010	4,529.7	87,907,485.5	Jan-2010	4,799.5	88,050,819.1	Jan-2010	4,529.7	87,907,485.5	2,615.2	
eb-2010	4,431.3	88,049,288.6	Feb-2010	4,705.6	88,201,398.8	Feb-2010	4,431.3	88,049,288.6	2,604.7	
/ar-2010	4,344.4	88,175,275.4	Mar-2010	4,622.1	88,335,438.3	Mar-2010	4,344.4	88,175,275.4	2,594.5	
pr-2010	4,250.1	88,311,277.4	Apr-2010	4,531.6	88,480,450.9	Apr-2010	4,250.1	88,311,277.4	2,581.8	
										-

Constant Liquid Rate Prediction

As discussed above, the user can choose to forecast the oilcut, watercut or water oil ratio prediction with time assuming a constant liquid rate. This is illustrated with the example below.

The user should select the Input Constant Liquid Rate Value from the Convert to Time Options dropdown list box, as shown below.

	Oil	Gas			
Decline	Exponential 🗸	Exponential 🗸			
'a' value	0.0007079637201	2]		
'n' value]		
Initial Rate	Use last rate 🗸 🗸	Use decline trend 🗸]		
Final Rate	3500				
mulative Pred	diction Setup	Gas	Oilcut	Watercut	Water Oil Ratio
nulative Pred	diction Setup	Gas	Oilcut	Watercut	Water Oil Ratio
nulative Pred	diction Setup Oil No	Gas	Oilcut	Watercut	Water Oil Ratio
nulative Pred Log Y Fit ? Gradient	diction Setup Oil No -0.0006234471116	Gas	Oilcut	Watercut	Water Oil Ratio
Log Y Fit ? Gradient Y Intercept	diction Setup Oil No -0.0006234471116 59694.524341609	Gas No	Oilcut No -2.9438519959740 2.7493389709057 [.]	Watercut	Water Oil Ratio
Log Y Fit ? Gradient Y Intercept Initial value	diction Setup Oil No -0.0006234471116 59694.524341609 Use last value	Gas No	Oilcut No -2.9438519959740 2.7493389709057' Use last value	Watercut	Water Oil Ratio
Log Y Fit ? Gradient Y Intercept Initial value Final value	diction Setup Oil No -0.0006234471116 59694.524341609 Use last value 3500	Gas No Gas No Gas No Gas O	Oilcut No -2.9438519959740 2.7493389709057 ⁻ Use last value 0.05	Watercut No	Water Oil Ratio

The user should then input a constant liquid rate value in the appropriate input box, as shown below. Then the user can press the **Calculate Predictions** button.

Cumulative Prediction Setup								
	Oil	Gas	Oilcut	Watercut	Water Oil Ratio			
Log Y Fit ?	🗌 No	🗌 No	No No	No No	No No			
Gradient	-0.0006234471116		-2.9438519959740					
Y Intercept	59694.524341609(2.7493389709057*					
Initial value	Use last value 🖌	~	Use last value	~	~			
Final value	3500	0	0.05	0	0			
	Con	vert to Time Options	Input Constant Liquid Rate Value					
		Input Liquid Rate	10000					





