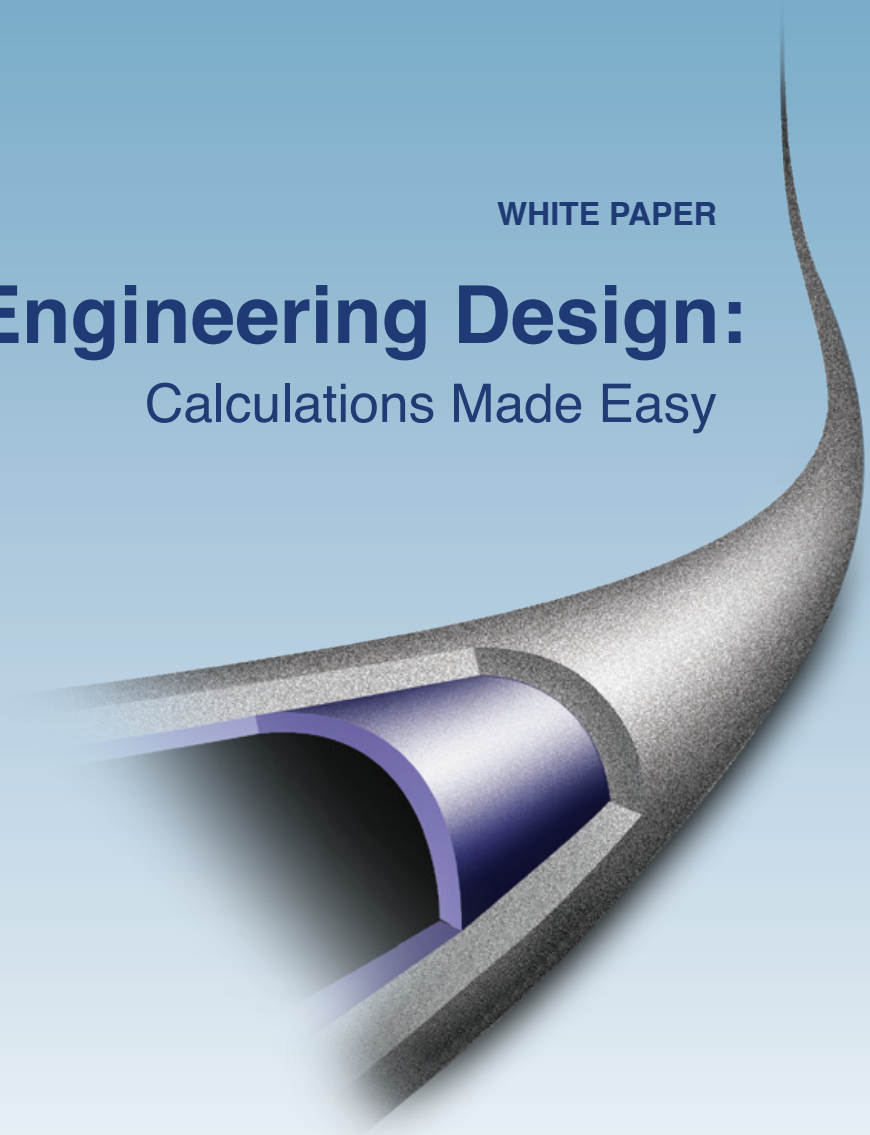


WHITE PAPER

Cementing Engineering Design:

Calculations Made Easy



CONTENTS

I. Challenges

Limitation	3
Error Proneness	3
Non-Standard Application	3
Drawing of Wellbore Schematics	3

II. Solution	4
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III. Benefits	5
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IV. Features

1. Various Unit Systems and User Logo Selection	6
2. Survey Data and 3D Well Path Visualization	7
3. Schematic and Cost Summary	8
4. End-of-Well Report	9
5. Balanced Cement Plug	10
6. Pore and Fracture Gradient	11
7. Sensitivity Study	12
8. String Wizard	13
9. Additive Database	14

V. Conclusion	15
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I. Challenges

Cementing operation success or failure can potentially make or break the financial viability of a well or project, so it is vital to correctly perform calculations and prevent mistakes during the design stage of a cementing job. As new technology evolves, the calculation of various parameters for cementing operations has become more challenging.

The following list highlights some of the common tasks in cementing engineering:

- Slurry volume
- Additive amount and cost
- Wellbore schematic
- Pressure differential
- “What if” or sensitivity study
- Professional report

Over the years, the industry has seen various calculation spreadsheets and technical documents. These spreadsheets have been used in the field and assist the engineers to perform engineering calculations. While being very popular, these spreadsheets have some drawbacks, which are listed here:

1. Limitation

There are so many parameters in the cementing operation, especially in the complicated casing configurations, that cannot be easily handled by the Microsoft Excel® spreadsheets.

2. Error Proneness

It is easy to modify spreadsheets. One engineer can create some cementing calculation sheets and before he knows it, every engineer in the team has their own version of the original one. While it is very easy to make modifications on existing spreadsheets, it is also very easy to introduce errors to the sheets, making calculation errors prone. This brings another issue, which is explained in the next item.

3. Non-Standard Application

Because everyone can potentially change the calculation of spreadsheets, the calculation accuracy may be compromised. Spreadsheets may not be a good way to standardize the calculation across the engineers.

4. Drawing of Wellbore Schematics

Spreadsheets may be able to draw some wellbore schematics, but making the schematics reflects that the dimensions of the input data could be very challenging.

II. Solution

Both operators and cementing companies desire to develop a standardized software tool, which would assist engineers and foremen, and raise the quality of work.

Pegasus Vertex, Inc. (PVI) and an US operator jointly developed [CEMVIEW](#), a comprehensive cementing engineering toolbox software. This easy-to-use software incorporates the operator's Global Best Practices for Cementing Operations. The goal of this software is to allow users to quickly and accurately perform the calculation through visual, sometimes animated schematics with cementing positions. In one session, users can create a variety of realistic combinations of casing/liner strings for land or offshore wells.

CEMVIEW can perform the following tasks:

1. Scalable calculation for basic volume as well as for material and cost
2. Database for business unit (BU) and vendor containing materials and cost
3. Expandable pipe database
4. 3D well path visualization
5. Pressure calculation
6. Casing and wellbore diagram with cementing positions
7. Sensitivity windows help users to study “what if” scenarios without having to run multiple cases
8. End-of-well report (Microsoft Word®) for e-mail distribution
9. Land wells and offshore wells

CEMVIEW can automatically generate end-of-well reports with the wellbore schematic. The input data file can also be emailed to other engineers for users to open and make modifications.

Since its release in 2006, CEMVIEW has been servicing both operators and service companies worldwide.

III. Benefits

Being a standalone and standardized application, CEMVIEW eliminates the time consuming and error-prone practice of separate spreadsheets and creates consistency between all engineers. The benefits CEMVIEW brings to cementing engineers include:

- Standardized application
- Consistency between all engineers
- Clear schematics
- Simplicity
- Costs calculated quickly
- Sensitivity study on uncertainties
- Save time and reduce risk

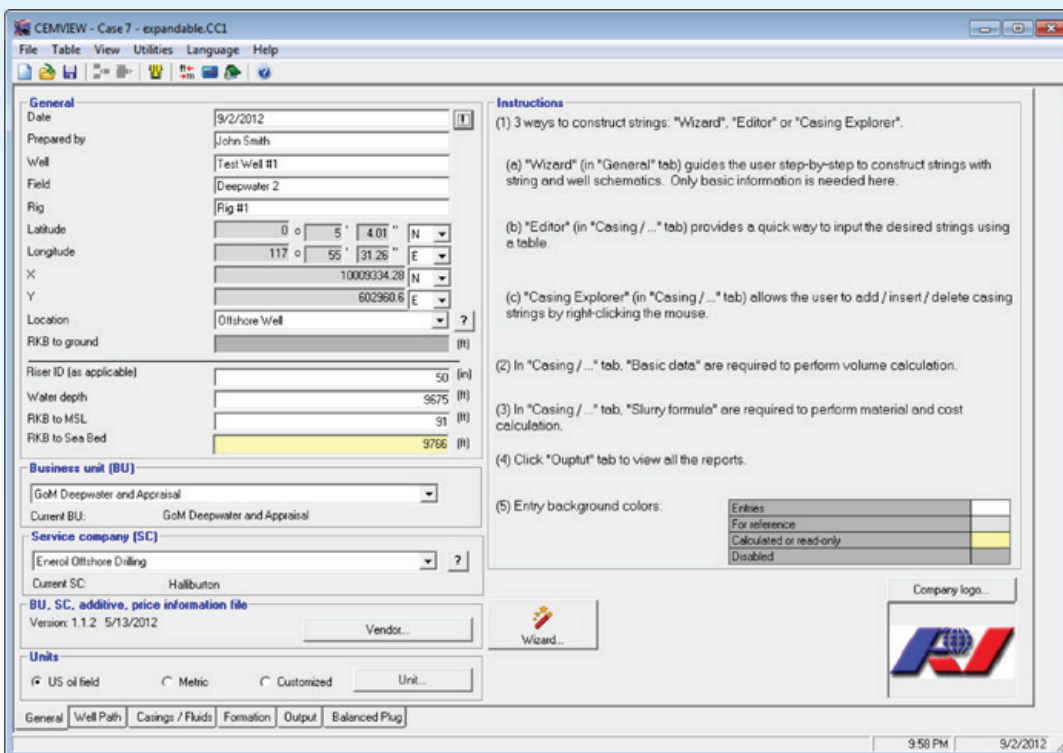
These benefits come as the results of the carefully designed features of CEMVIEW.

IV. Features

1. Various unit systems and user logo selection
2. Survey data and 3D well path visualization
3. Schematic and cost summary
4. End-of-well report
5. Balanced cement plug
6. Pore and fracture gradient
7. Sensitivity study
8. String wizard
9. Additive database

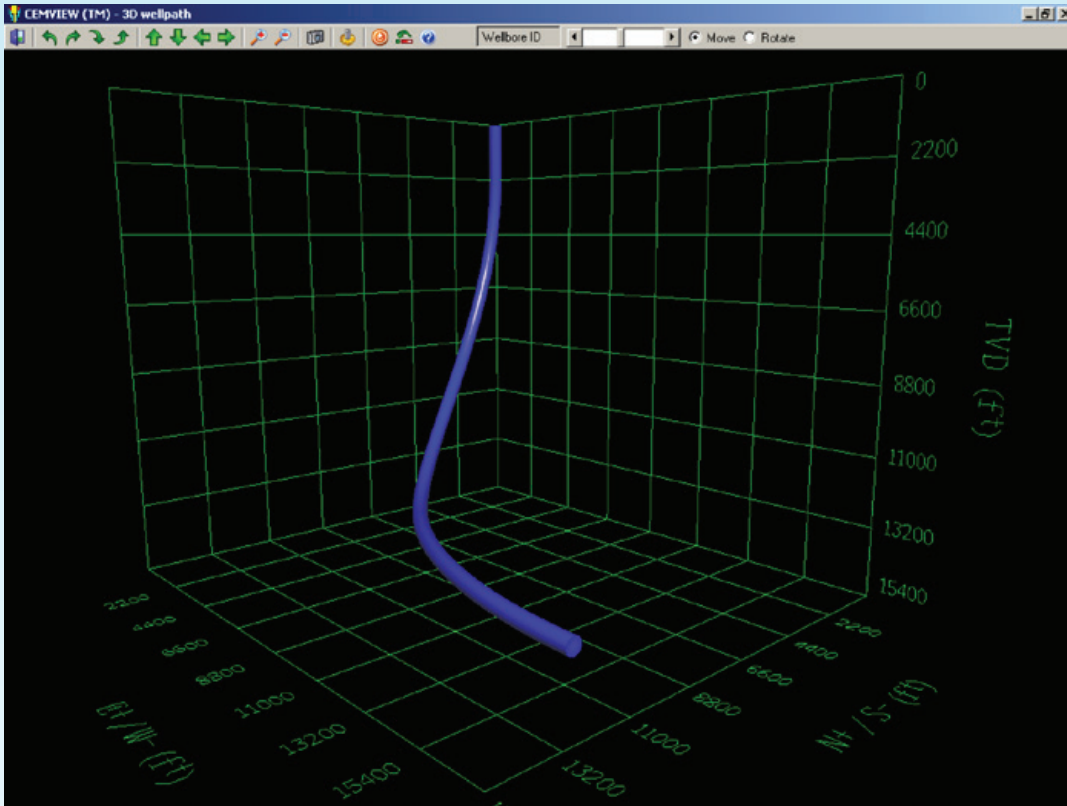
1. Various Unit Systems and User Logo Selection

Users can select US oil field, metric or any combination of units. Logo can be selected and displayed on screen and report.



2. Survey Data and 3D Well Path Visualization

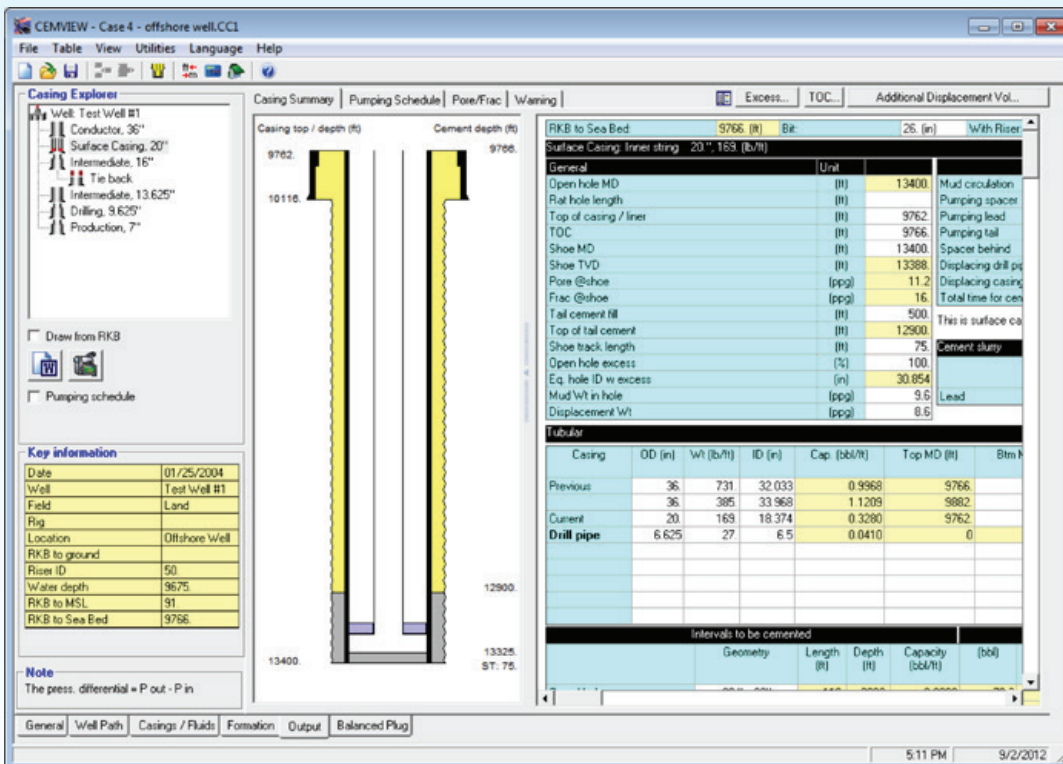
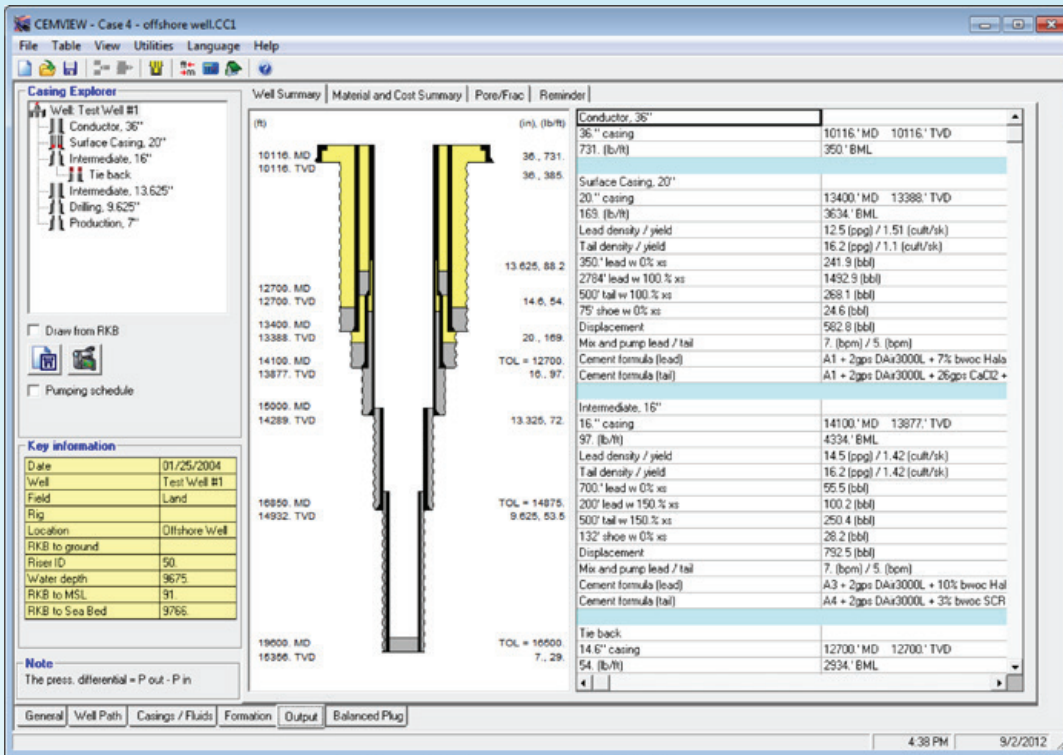
Survey data can be manually input, copy-pasted from Microsoft Excel® sheet or imported from text file, or even PDF® file. Then a 2D or 3D well path can be plotted.



Casing Explorer contains a list of all the casings for the well. When the well is selected, the right panel displays the casing summary.

3. Schematic and Cost Summary

“Output” tab displays the wellbore schematic and breakdown costs for all the casing strings in a well.



4. End-of-Well Report

CEMVIEW is smoothly integrated with Microsoft Office® in generating end-of-well reports. Each string has its own page summary.

Business unit: GOM Deepwater and Appraisal
 Service company: Global Service
 Location: Offshore Well
 RWD to Sea Bed: 9766 (ft)
 Prepared by: John Smith
 Well: Test Well #1
 Field: Land
 Rig:
 Date: 01/25/2012

Addives	Unit	36"	20"	16"	14.6"	13.625"	9.625"	7"	Total amt.	Total cost (\$)
Spacer										
Musol A	(gal)		480.0	282.0			82.8	102.4	947.8	2180
Surfactant B	(lb)		240.00			150.88	131.10		521.98	6420
Pen 5M	(gal)		2000.0	196.3		209.9		147.2	2553.4	29619
Barite	(lb)		1840.00	231.20					2091.2	4232
Cement slurry										
DAr3000L	(gal)		15890.0	3830.0		2972.0	2370.0	1452.0	26514	3685
CaCl2	(gal)		38844.0			3978.0			42822	42822
Halag 700	(lb)		42447.58	13857.48		8681.84	7797.30		72784.2	1857453
Zonsepall 2000	(lb)		11234.88					5459.52	16694.4	105842
Sch100L	(lb)			3107.64				3412.20	10975.44	39512
WG17LXP	(lb)			3056.88		752.00			3808.88	13331
Cement type										
A1	(sk)		7945			1486			9431	1311
A3	(sk)			813					813	18601
A4	(sk)			1102				726	1828	6398
A2	(sk)						1185		1185	1185
Casing hardware										

Addives	36"	20"	16"	14.6"	13.625"	9.625"	7"	Total cost (\$)
Spacer		31468	2927		4291	1803		1943
Lead & Tail		1195544	376682		228584	218357		47099
Dry cement		1104	22458		207	1185		2541
Casing hardware								
Total		1228136	401447		233061	218345		51583

Business unit: GOM Deepwater and Appraisal
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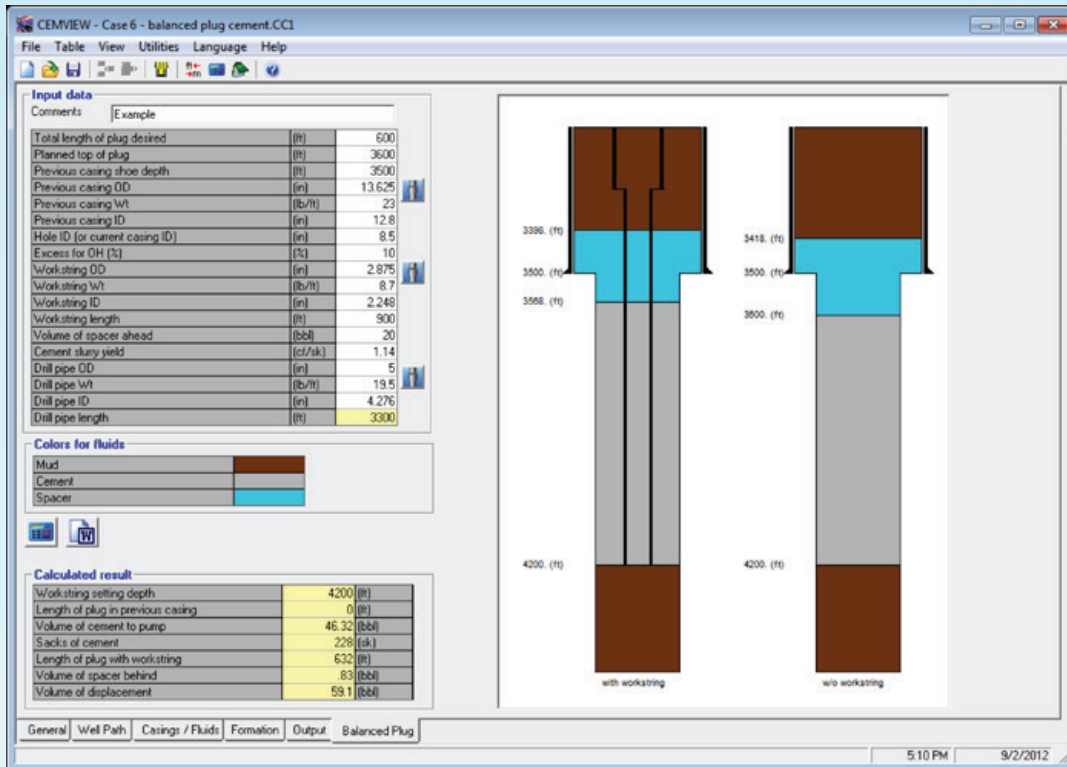
Item	Unit	Value	Cost (\$)
Open hole depth	ft	7333	
Open hole volume	cu ft	1092.1	
Open hole annular vol.	cu ft	195.1	
Open hole annular vol. w. sl.	cu ft	3450	
Open hole annular vol. w. sl. (incl. pipe displacement)	cu ft	171.7	
Casing displacement vol.	cu ft	67.3	

Item	Unit	Value	Cost (\$)
Open hole annular vol.	cu ft	195.1	
Open hole annular vol. w. sl.	cu ft	3450	
Open hole annular vol. w. sl. (incl. pipe displacement)	cu ft	171.7	
Casing displacement vol.	cu ft	67.3	
For liner + ring, casing bottom volume	cu ft	309	
For liner + ring, casing bottom volume	cu ft	117	
Total pipe interior volume	cu ft	192.6	

Item	Unit	Value	Cost (\$)
Spacer	cu ft	307.80	
Lead	cu ft	307.80	
Tail	cu ft	307.80	
Total	cu ft	923.40	

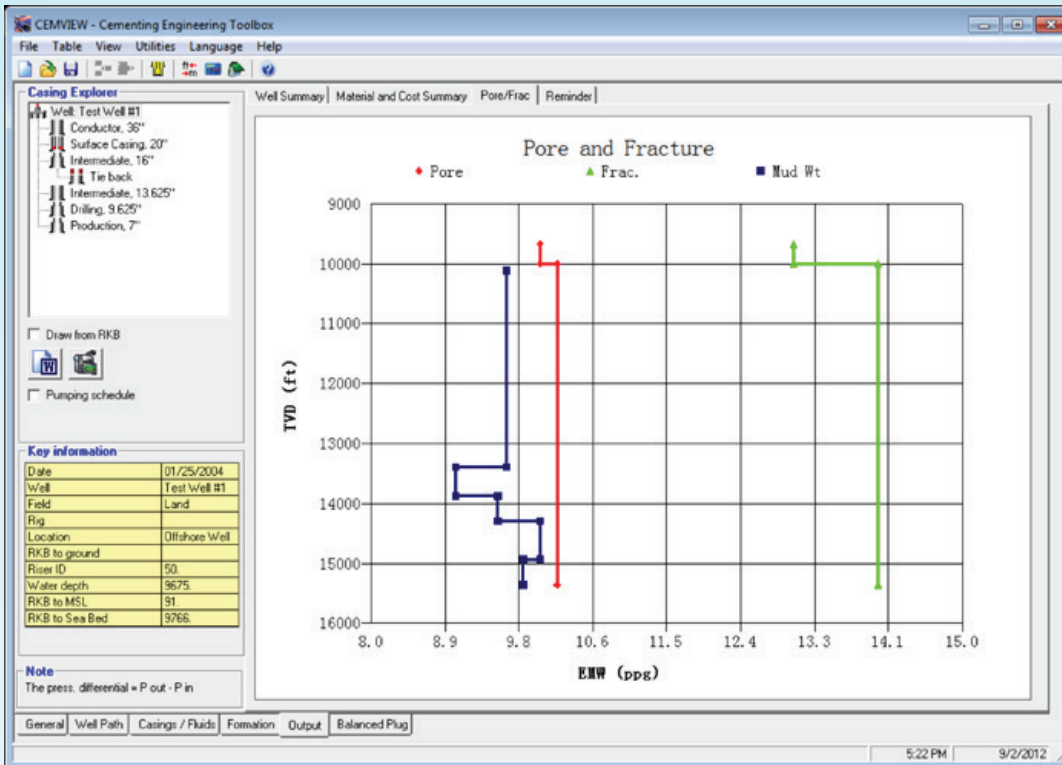
5. Balanced Cement Plug

CEMVIEW calculates the volumes for balanced cement plug.



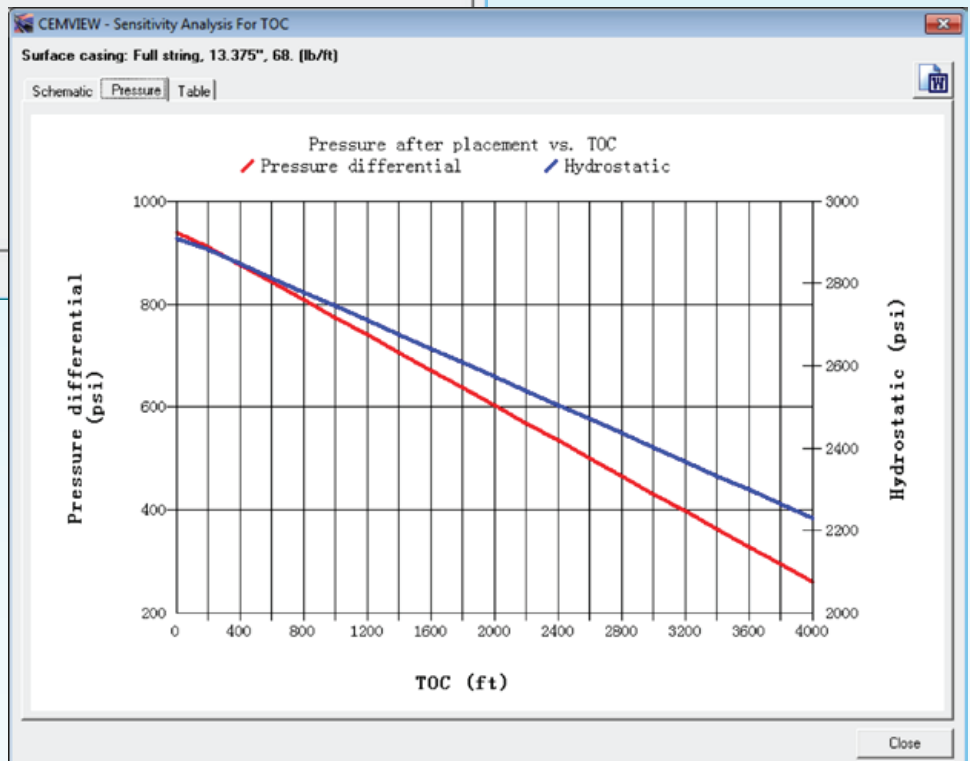
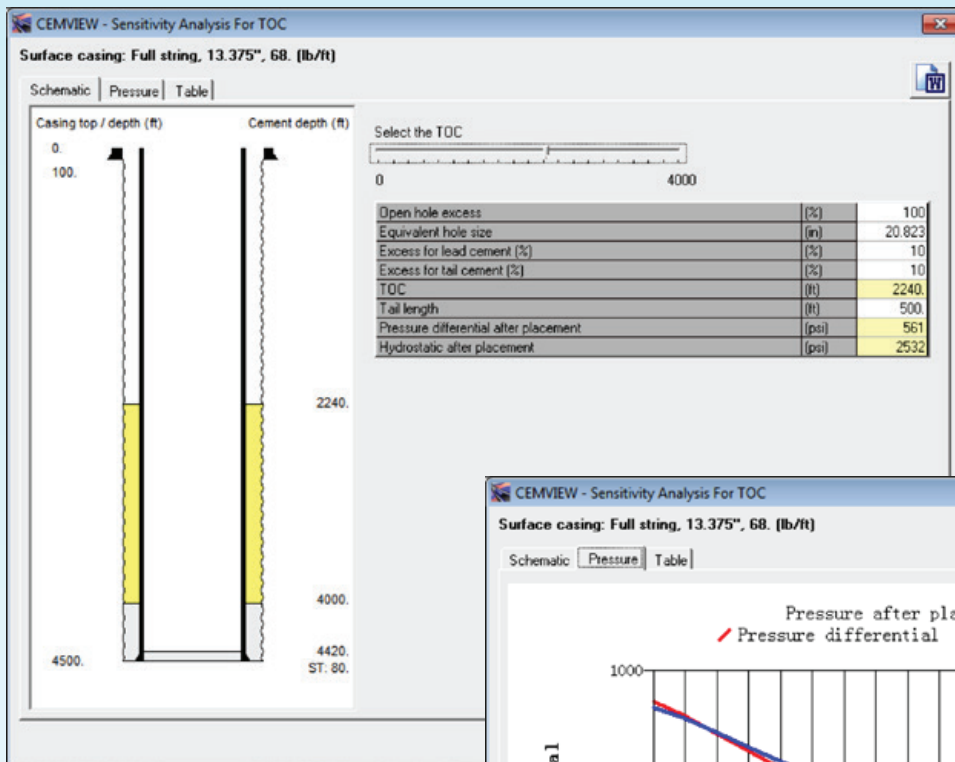
6. Pore and Fracture Gradient

Pore and fracture gradient can be plotted with the mud weight.



7. Sensitivity Study

Sensitivity study helps users to study “what if” scenarios without having to run multiple cases. This sensitivity study on TOC lets users see casing, cement schematics and pressure differentials at various top of cements.



8. String Wizard

String Wizard guides users step by step to construct a well. Users can view the casing and well schematic as data are entered.

The screenshots illustrate the following steps in the String Wizard process:

- Welcome to the String Wizard:** A window with a well image and introductory text: "Wizard will guide you through multiple steps to construct the casing strings for the well. Please check the following key information. To continue, click Next." It includes a "Key information" table.
- Add casing / liner string:** A window with a table for adding casing/liner strings.

Description	ID	Start	Stop
Production	1	0	10000
Intermediate	2	10000	15000
Intermediate	3	15000	18000
Intermediate	4	18000	20000
Intermediate	5	20000	25000
Intermediate	6	25000	30000
Intermediate	7	30000	35000
Intermediate	8	35000	40000
Intermediate	9	40000	45000
Intermediate	10	45000	50000
Intermediate	11	50000	55000
Intermediate	12	55000	60000
Intermediate	13	60000	65000
Intermediate	14	65000	70000
Intermediate	15	70000	75000
Intermediate	16	75000	80000
Intermediate	17	80000	85000
Intermediate	18	85000	90000
Intermediate	19	90000	95000
Intermediate	20	95000	100000
- For each individual casing / liner string, please input information (Step 1 of 2):** Multiple windows showing input fields for well size, casing weight, casing composition, and casing length. Each window includes a well schematic diagram.
- For each individual casing / liner string, please input information (Step 2 of 2):** A window for final adjustments and confirmation, including a well schematic.
- Final Well Schematic:** A large window showing the complete well schematic with all casing strings and their depths.

9. Additive Database

Users can set up different business units and prices of additives in various regions. The database allows users to calculate the amount of material required and cost for additives.

The screenshot shows the 'CEMVIEW - Vendor' application window. At the top, there are input fields for 'Version number' (Major: 1, Minor: 1, Revision: 2) and 'Date stamp' (Month: 5, Day: 13, Year: 2012). Below this is a tree view for 'Business Units and Service Company' with categories like 'GoM Deepwater and Appraisal', 'GoM Development and Operations', and 'XYZ Thailand LTD'. The main area displays a table of additives under the 'Additives for Cement' tab.

	Name	Description	Type	Unit cost	Unit cost	Default unit
1	B004	Microblend Extender	Solid	\$/lb		0 % bwoc
2	B078	Dispersant	Liquid	\$/gal		0 gps
3	B155	Retarder	Solid	\$/lb		0 % bwoc
4	B806	GASBLOK, CR	Liquid	\$/gal		0 gps
5	D008	Diacel LWL	Solid	\$/lb		0 % bwoc
6	D013	Retarder	Solid	\$/lb		0 % bwoc
7	D018	Ilmenite Weighting Agent	Solid	\$/lb		0 % bwoc
8	D020	Bentonite Extender	Solid	\$/lb		0 % bwoc
9	D024	Gilsonite Lost Circulating Additive	Solid	\$/lb		0 % bwoc
10	D028	Retarder	Solid	\$/lb		0 % bwoc
11	D029	Cellophane Flakes	Solid	\$/lb		0 % bwoc
12	D030	Cement Silica	Solid	\$/lb		0 % bwoc
13	D031	Barite	Solid	\$/lb		0 % bwoc
14	D042	KOLITE Lost Circulation Additive	Solid	\$/lb		0 % bwoc
15	D046	Antifoam	Solid	\$/lb		0 % bwoc
16	D047	Antifoam	Liquid	\$/gal		0 gps

Buttons at the bottom include 'Login to Edit...', 'Save', and 'Close'.

V. Conclusion

Approved and endorsed by a major US operator, CEMVIEW aims to standardize cementing engineering calculations. Having a standard software application provides consistency and confidence in results and helps reduce unnecessary errors which could jeopardize cementing operations.

For more information on [CEMVIEW](#), please contact PVI at:

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