

COZVIEW/COZSIM

User Manual Supplement No. 1

Issued Date: August 20, 2013

This user manual supplement includes the following new functionalities:

- Case management
- WAG Schedule

Case Management

General Description:

It is often useful in conducting a study to modify a single or a few parameters in the data and make a new simulation run. Once the simulation run is complete the user will want to compare the results (plots and 3D views) of the two (or more) case. In the case of plots, the user may wish to show multiple case results on the same plot. For 3D views the user will want to easily view the same array (e.g. oil saturation) for two different simulation cases. The goal is to ease the analysis process as the user attempts to improve or compare simulated performance of alternative cases.

Cases are defined as a set of input data within a COZ project that have different property values for user selected properties.

Examples of properties that may change between cases:

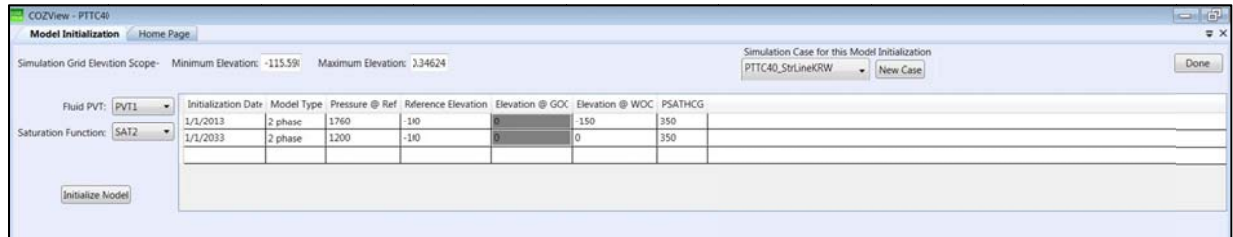
1. relative permeability curves
2. well completions
3. well constraints
4. depletion strategies
5. layer properties *
6. initialization properties*

*The user is cautioned relative to creation of multiple cases with different volumetrics. While this is allowed, comparison of simulation results may not be appropriate.

WARNING: The user should not change the structure, well locations, or grid dimensions between cases. The user is cautioned to keep a record of parameter changes between cases. While COZView allows many parameters to be changed between cases, only a few can be identified or retrieved by the case name in COZView.

New Case – Initialization Changes

Case management may start at the **Model Initialization**. A selection box has been added to create a New Case or utilize the existing case. A New Case name is suggested, but the user can change this name as they wish. A comments field is also provided to aid the user in distinguishing between cases. This should be filled in by the user. The user **cannot** return to a previous case.



This allows the user to change formation properties, PVT table, Saturation function table and/or initialization parameters for the new case. All other data from the prior case will be retained in the new case subject to changes in the **Prediction Period Section**.

When the user selects the **Initialize Model** button the **Model Volumetrics** screen will appear along with the Simulation status window. Once the simulator has completed the initialization, the volumetric values by phase will appear in the table. The table now has a Case Name associated with each volumetric calculation; otherwise there is no change from the previous version.

If the user has only changed pre-Model Initialization data to this point and does not wish to change any well or field constraints or limits, they can proceed directly to **Run Simulation**. The user should select the new Case Name created in **Model Initialization Section** from the dropdown menu and set the End Date to the appropriate value. The simulation run will be launched accordingly. Note that all well and field constraints and limits will be the same as the prior case.

If the user wishes to change well or field constraints or limits in addition to the Initialization parameters, they may do so in the appropriate screens. Be sure to **Save** when changes are made. When the user is ready to submit the new simulation run (**Run Simulation**), they should select the new Case Name created in **Model Initialization Section** from the dropdown menu and set the End Date to the appropriate value. Select GO to launch the simulation run.

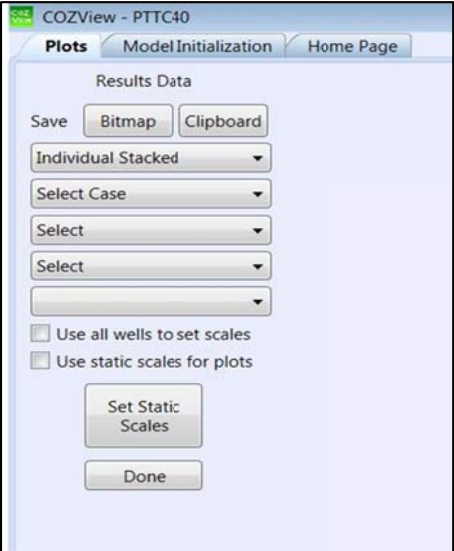
New Case – Prediction Period Changes Only

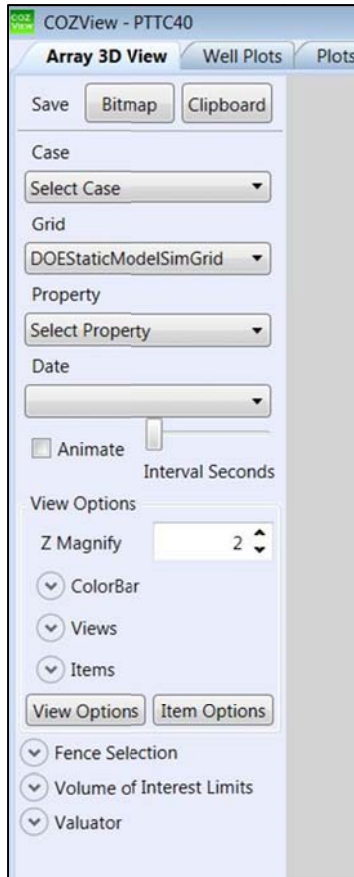
If the user wishes to create a new Case that is based on changes to well and field constraints and limits, but does not require changes to Model Initialization data, they can change the data in the appropriate screens. In the **Field/Facility Parameter/Controls** screen select the correct Case in the *Show Constraints for* box. Be sure to Save when changes are made. (As a new case cannot be created on the **Field/Facility Parameter/Controls** screen, this may require the new case to be defined on the **Run Simulation** screen, a refresh of the **Controls** screen, and selection of the new case on the refreshed **Controls** screen.

When the user is ready to submit the new simulation run, a New Case can be created at the **Run Simulation** screen. Be sure the new case name is selected after creating the New Case. Select GO to launch the simulation run. All well and field data changes will be associated with the new case name.

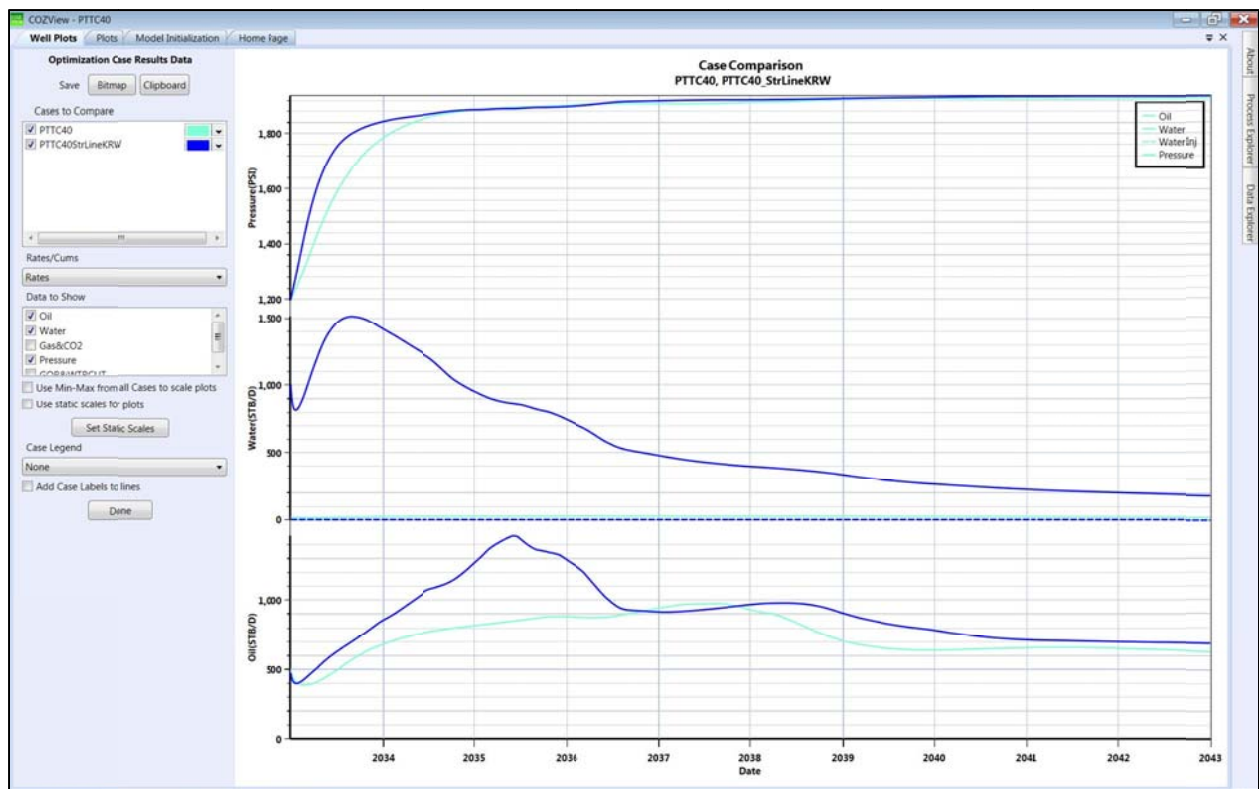
Simulation Results

All plots, tables and 3D Views contain a selection box for the Case. All prior cases run in the project will be available for viewing in the appropriate display.





Case Comparison Plots in the **Simulation Results** menu allows the user to compare selected field level results on any of the cases run in a project on the same display plot.



Case Summary

The user can view a table of all cases run in the project under **Case Management** in **Utility Functions** in the **Process Explorer** section. The comments field can be altered by selecting a case and the **Edit** button. Cases can also be deleted by selecting the case and the **Delete** button.

Case	CaseType	Create Date	Update Date	Comments
Project - Franinet				
Franinet	Prediction	4/18/2013 10:56:08 AM	8/22/2013 2:04:09 PM	Base Case
Franinet_Case1	Prediction	8/21/2013 4:03:19 PM	8/23/2013 2:04:36 PM	Status of Base Case
Franinet_Case2	Prediction	8/21/2013 4:37:59 PM	8/22/2013 2:04:46 PM	Removed Recycle

The status of the project data base (layer properties, well constraints, field constraints, etc.) is consistent with the last case run only. (SQL data bases for prior simulation runs are NOT retained.) The user is cautioned not to delete the last case run unless all cases (excluding the “base” case) are being deleted and the “base” case is being re-formulated. Deleting the last case run may result in an incomplete data base and impact subsequent simulation runs in this project.

File Naming Convention

The file naming convention has been changed to include the case name in addition to the project name. A typical file name is now *Projectname_Casename.COZOUT* or *Projectname_Casename.COZdat*.

Be sure to keep in mind the rules concerning screen refreshing. A new case will not appear in a Case box if the particular screen has not been refreshed since the creation of the new case.

WAG Schedule

General Description:

Many CO2 injection projects utilize a process referred to as WAG (water-alternating-gas). Injection into designated wells is varied between CO2 and water on a defined schedule. In theory this maximizes use of the scarce CO2 resource and provides mobility control for the advancing CO2 front. A new functionality has been added to COZView to make scheduling of the WAG process easier. Prior to this, WAG scheduling had to be manually specified. COZSim has been able to handle this process from the beginning.

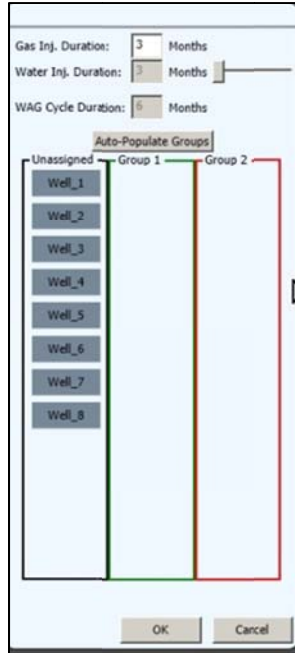
Establishing WAG Injection Wells

In the **Well Constraints** section each well used in the simulation must be identified with a specific *Well Type*. A new Well Type has been added, **WAG Well**. The user must identify the injection wells that will be used in the WAG process, when they will start the WAG, the maximum individual well water and gas injection rates and the maximum individual bottom hole injection pressure. The gas injected during a WAG cycle can be hydrocarbon gas (HCG) or CO2. This will be identified in the **Field/Facility Parameters/Controls** section. Select **Done** to save.

Active?	Well Name	Effective Date	Well Type	Oil Rate STB/d	Water Rate STB/d	Gas Rate MSCF/d	Liquid Rate STB/d	Water Inj Rate STB/d	Gas Inj Rate MSCF/d	BHP
<input checked="" type="checkbox"/>	Well_10	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_11	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_16	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_8	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_14	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_15	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_12	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_13	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_4	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_5	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_1	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_2	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_3	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_7	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_6	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_8	1/1/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_6	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_5	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_8	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_7	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_2	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_1	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_4	1/1/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_3	1/1/2014	WAG Well					1000	5000	2500

Setting WAG Cycle Schedule

The user must then select the **WAG Schedule** button. Select **Yes** to the save query. The first time this screen is entered all wells previously identified as WAG wells will be shown in the left *Unassigned* column.



Each of these wells must be “assigned” to a Group. The number of possible Groups is based on the duration of the gas and water injection per WAG cycle. The concept is that all WAG wells will be active once the WAG schedule is initiated. A full cycle requires that all wells have injected water and gas for the defined durations once.

In the WAG screen above, the gas injection duration has been set to 3 months by the user (the default value is 1). Based on the gas injection duration, the water injection duration is initially set to the same value; 3 months in this case. This establishes the total WAG cycle duration at 6 months – 3 months of water injection and three months of gas injection. As the injected gas is typically purchased from an outside source and must be used on a near constant volume basis; gas injection must occur in at least some wells throughout the WAG cycle; hence, the need for two groups in this example – one of the groups always injecting gas. (The number of wells in each group is up to the user.)

The user can assign the wells to groups by dragging each well from the *Unassigned* column to one of the *Group* columns. Typically, wells are grouped based on surface facilities and/or pattern requirements.



Select **OK** to save.

Note that the WAG schedule will be repeated in the simulation run until the run completes or the well types are changed for the WAG wells by the user in the **Well Constraint** section. The gas and water volumes used in each well in the WAG cycle can be changed later in the simulation run period in the **Well Constraints** screen, but the injection duration times during the WAG cycle cannot be changed.

The number of months of water injection relative to the number of months of gas injection can be changed with the slide bar. The duration of water injection can be changed to multiples of the gas injection duration – in this case 3 months of gas, 3, 6, 9, etc. months of water. Changing the water injection duration will change the total WAG cycle duration. This in turn changes the number of possible groups.

Once the WAG groups have been established the user can view the well constraints for all wells in a given group by selecting a group from the dropdown menu in the top left corner of the **Well Constraints** screen.

Active?	Well Name	Effective Date	Well Type	Oil Rate STB/d	Water Rate STB/d	Gas Rate MCFGYd	Liquid Rate STB/d	Water Inj Rate STB/d	Gas Inj Rate MCFGYd	BHP
<input checked="" type="checkbox"/>	Well_2	11/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_3	11/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_4	11/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_1	11/2013	Liquid Producer				1000			500
<input checked="" type="checkbox"/>	Well_3	11/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_4	11/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_3	11/2014	WAG Well					1000	5000	2500
<input checked="" type="checkbox"/>	Well_1	11/2014	WAG Well					1000	5000	2500

Group WAG Implementation

As described above, the number of Groups is dependent on the duration of injection for water and gas. The user does not need to place wells in all of the Groups. However, not doing so will result in some portion of the total WAG cycle duration being carried out with no gas injection.

If multiple Groups (say 3) are required, the cycle sequence is as follows for a total WAG cycle through all wells:

Group	First Gas Injection Period	Second Gas Injection Period	Third Gas Injection Period
1	Gas	Water	Water
2	Water	Gas	Water
3	Water	Water	Gas

The well plot below is an example of a 1 month CO₂ injection/1 month water injection WAG cycle starting in 1/1/2014 after one year of production.

