

tnavigator 214

Rock Flow Dynamics

December 2021





tNavigator installation:

Setup software (an installer) for the Linux version of tNavigator has been added. The installer runs in the console and is implemented as a sequence of ASCII graphic screens. The program also installs the user documentation.

Log panel:

A common view of the log panel with an option to search and filter messages by tags or mask is now supported for Simulator, Geology Designer, Model **Designer, Network Designer, and PVT Designer.**



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In the Simulator kernel:

- The calculation of polymer options on GPU is now supported.
- For black oil models, the option of multicomponent water is now supported.

Labyrinth inflow control devices for multisegment wells are now supported.



PMIXLIN • **PMIXNLIN PMIXTAB PMIXVTAB PLYELVSVCS** • **PLYSHEARA PLYELVSVA**





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PLYELVMAXA



In the Simulator kernel:

For isothermal compositional models in E3 format, the option of modeling a two-phase gas-water system using an equation of state is now supported (the GASWAT keyword).

For geomechanical modeling, the linear isotropic plasticity model is now supported. The tensor of plastic deformations for such a model can be implemented as a function of the parameters of the dynamic model.











In the tNavigator graphical interface:

 Oil production graphs for various recovery mechanisms are now available in black oil models (oil produced due to rock compaction, due to water influx, etc.)







In the Assisted History Matching and Uncertainty module:

A new mode to create a neural network for a large number of parameters has been implemented. In that case, a single neural network is built, which helps reduce the training time.







In Geology and Model Designers:

It is now possible to create Page Layout with several pages. This option allows the visualization of objects that do not fit on one page. 2D-Maps of any size can be printed using a simple A4 printer.

The Preview option is now available to control the data exchanging process in the Project Data Exchanger.











In Geology Designer:

It is now possible to set a custom name for each imported well log. A dictionary of log names (mnemonics) can be predefined and applied to all imported logs.

An interactive tool for quality control of fault creation has been added: Fault QC.







In Geology Designer:

New tools are available to model Discrete Fracture Networks (DFN). New settings are available to control fracture orientation within the modeling area. In the list of available windows and tabs, a new object has been introduced: Stereonet/Directional Rose.

An option for azimuthal images visualization and interpretation during well navigation is now available. An option to generate synthetic images for the drilled well based on the reference well data has been added.







In Geology Designer:

- New tools are available to work with geobodies and triangulated surfaces:
- automatic creation of geobodies based on point sets or fence polygons,
- interactive editing of geobodies' triangulated surfaces in 3D,
- properties creation by geobodies,
- import/export of triangulated surfaces and geobodies in .tsurf, .ply, .dxf formats.









10

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In Model Designer:

- The following fluid properties associated with the analytical model of polymer injection are now supported:
- the elongational viscosity multiplier as a function of the polymer concentration in a table,
- the elongational viscosity multiplier as a function of the stream velocity,
- the temperature-dependent polymer half-life period,
- etc.









11

In Model Designer:

- In Fracture Simulator, it is now possible to take into account the mutual influence of fractures implemented at different wells to model the fracture stage at the current well.
- In RP Designer, a new tab titled "SRP" (scaled relative permeabilities) has been added to calculate the hysteresis effect and RP curves in the presence of surfactants.
 - It is now possible to visualize RP curves by changing endpoints.





In Well Designer:

A new object—Sucker Rod Pump—has been added.

In Network Designer:

It is now possible to import and export data for network objects in tabular form in a user-specified format.

In PVT Designer:

In the workflow, compositional and black oil variants can now be matched to samples.





13

Cross-module changes

Many changes involved in tNavigator modules integration influence multiple modules, but are only mentioned once in this presentation. These include:

- A common view of the log panel;
- Highlighting of calculations with variables in workflows;
- New grid properties in Model Designer and Simulator;
- ...etc.

For the full list of changes to each particular module, please read the **Release Notes.**

This presentation contains only the main changes to every module. The

complete list of changes, together with the new keywords and options, are

likewise available in the Release Notes.

ے ا	Bookmarks
	TNavigator Library
G	✓ ☐ 1. tNavigator 21.4
	1.1. tNavigator Kernel (Simulator)
	1.2. Graphical User Interface
	1.3. Assisted History Matching a Uncertainty
	1.4. Geology Designer and Mod Designer
	🗍 1.5. Geology Designer
	🗍 1.6. Model Designer
	1.7. PVT Designer
	1.8. Network Designer
	🗍 1.9. Well Designer
	1.10. Licenses and License Serve
	1.11. Documentation, Localization

tNavigator Kernel

Simulator kernel 21.4

GPU calculations

The following calculations are supported on GPU:

- Baker's model for relative phase permeabilities of gas and water (BAKER1, BAKER2).
- The calculation of rock hysteresis (ROCKCOMP HYSTER/BOBERG + ROCKTABH).
- PLYSHEARA, PLYELVSVA, PLYELVMAXA).

In full GPU mode (GPU_MODE 4, 5):

- The calculation of aquifers for compositional models with multicomponent water.
- The simultaneous chopping of pressures and saturations (RUNCTRL CHECKP 2).
- The export of boundary conditions for split models.

The calculation of variables that are taken from the previous timestep in the AIM scheme. **TNavigator**®

The calculation of polymer options (PMIXLIN, PMIXNLIN, PMIXTAB, PMIXVTAB, PLYELVSVCS,

Options of multicomponent water and chemical reactions in black oil mode

- For black oil models of E3 format, the option of multicomponent water is now supported (the C keyword).
- For black oil models of E3 format (including mo the option of multicomponent water), the model chemical reactions is now supported (the REAC keyword).

Simulator kernel 21.4

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		•	

GASWAT option

For isothermal compositional models of E3 format, the option of modeling a two-phase gas-water system using an equation of state is now supported (the GASWAT keyword).

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New options for models in IN, NE formats

For models in NE format:

Polymer injection, polymer adsorption, and polymer effect on permeability and viscosity are now supported (the keywords are **VISCOSITY, ADSORPTION, PERM_REDUCTION, SHEAR,** POLYMER, EPHIP, STREAM_POLYMER).

For models in IN format:

- The Python object CellSelectionFamily (a set of blocks) is now supported.
- The Python operations in the SCHEDULE section are now supported.

Permeability change in SCHEDULE

The change of permeability in the SCHEDULE section is now supported via the multipliers

PERMMULT{X,Y,Z,XY,XZ,YZ,XYZ}.

Labyrinth inflow control devices

Labyrinth inflow control devices for multisegment wells are now supported (the WSEGLABY keyword)

An inflow control device (ICD) is a proven well completion technology designed to equalize the inflow along a wellbore

Connection factor calculation

The formula for calculation of connection factors for virtual perforations has changed: it now uses the harmonic average instead of the sum of the permeabilities on both sides of the fracture. The legacy logic is turned on by the FRACTURE_VIRTUAL_CF_LOGIC SUM option of the **TNAVCTRL** keyword.

Geomechanical modeling

 \boldsymbol{x}_{s} components σ , O_{33h} σ $\sqrt{\sigma_{23}}$ $\sigma_{31,}$ σ_1 σ_{32} $\sigma_{\rm m}$ σ_{12} <u>σ</u>, \boldsymbol{x}_{i} σ **GMPLSTRXY** \boldsymbol{x}_{2} *E*₁₂ ' ϵ_{13} e_{11} ' **GMPLSTRXZ GMPLSTRX** *E*₂₃ ϵ_{22} E21> **GMPLSTRY GMPLSTRYZ** E_{31} E_{32} GMPLSTRZ

The linear isotropic plasticity model is now supported. The tensor of plastic deformations for such a model can be implemented as a function of the parameters of the dynamic model using the keywords GMPLSTRX, GMPLSTRY, GMPLSTRZ, GMPLSTRXY, GMPLSTRXZ, GMPLSTRYZ to define the tensor's

$$\varepsilon_{ij} = \varepsilon_{ij}^p + \varepsilon_{ij}^e$$

Hooke's law, in accordance with the initial conditions and the correction for plastic deformations, takes the following form:

$$\sigma_{ij} = \sigma_{ij}^{t=0} + 2\mu(\varepsilon_{ij} - \varepsilon_{ij}^p) + \lambda \,\delta_{ij}(\varepsilon_{kk} - \varepsilon_{kk}^p) - \alpha(p - \varepsilon_{kk}^p) - \alpha(p$$

Visualization of the Plastic strain tensor

Plastic strain tensor components can now be visualized in 2D and 3D (2D or 3D \rightarrow Grid Properties \rightarrow

Calculated → Plastic Strain Tensor)

Definitions	Auto Sync	▲ 2D 3D Histogram
Grid Properties	General Settings	Plastic Strain Tensor 7
Cap. Press. of Gas-Oil 🔥		
Pore Volume at Res. cond.		0.00087
Porosity	T Scaling	0.00065
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Effective Stress tensor Sigma	0,4167	0.00042
Effective Stress tensor Sigma	0,4167	0.00045
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Lo i natografi	✓ Well Names	
Fluid Properties	Well Status	
Cabadula C	Show All Wells	

associated with it.

24

Graphical Interface

Graphical Interface 21.4

Graphs of pressure drops in network nodes

- Graphs of pressure drops in network nodes are now supported (the NETWORK option):
 - the pressure drop in a production network node (GPRB);
 - the pressure drop in a gas injection network node (GPRBG);
 - the pressure drop in a water injection network node (GPRBW)
 - (Graphs \rightarrow Node \rightarrow Pressure \rightarrow Node Pressure Drop)

The network type is set via parameter 7 of the NODEPROP keyword

		network
G-45 Node Pressure Drop	Gas injection network	Q > Wells > Groups ✓ Prod, Network
	\bigcirc \diamond Wells \diamond Groups \checkmark Prod. Network \checkmark SL-2 \checkmark C-18 \checkmark T6 \diamond G-45 \diamond T5 \diamond C-19 \checkmark Node Pressure \bigcirc Node Pressure Drop \square Node Pressure Drop	 ✓ SL-2 ✓ C-18 ✓ T6 △ G-45 > T5 > C-19
Date		
(?)		26

Water injection

Displaying graphs by blocks in binary format

Definitions	Objects
Grid Properties	
Graphs	> Wells > Groups
Graph Templates	✓ Blocks
Models	> FIPNUM
Q	Filters Run Statistics
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	- Parameters
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	Y Block
> Predefined Templates	Water velocity in the positive I direction
Graph Template 1	✓ Water velocity in the positive J direction
+- 🖻 🖌 👗 生	 Water velocity in the positive K direction Oil velocity in the positive I direction
Waterflood	Oil velocity in the positive J direction
2D Histogram	Gas velocity in the positive I direction
Fluid Properties	 ✓ Gas velocity in the positive J direction ✓ Gas velocity in the positive K direction
Schedule	

Graphs for blocks saved in UNRST/UNSMRY binary format can now be visualized (including the velocities of oil, gas and water). It is necessary to set the output to the restart files so that they contain the corresponding property (for velocity, the VELOCITY option of the RPTRST keyword should be used) and the I, J, K indices of the grid blocks using the B* mnemonics in the SUMMARY section (for velocities, the

mnemonics BVELW, BVELO, BVELG should be used) (Graphs \rightarrow Graph Templates \rightarrow Blocks \rightarrow Parameters)

Graphs for oil recovery mechanisms

 B_{o} is the oil volume factor.

Oil production graphs for various recovery mechanisms are now available in black oil models (oil

produced due rock compaction, water influx, etc.) (Graphs \rightarrow Analytics \rightarrow FIPNUM \rightarrow Parameters)

relation to total oil production

AHM and Uncertainty

AHM and Uncertainty 21.4

Neural Network Proxy Model

reduce the training time

Previously, for each selected object parameter, its own neural network was created

A new mode to create a neural network for a large number of parameters has been implemented

(Create Neural Network Proxy Model from Selected Variants \rightarrow the tab Proxy Models \rightarrow Create Single

Neural Network For All Object-Parameters). In that case, a single neural network is built, which helps

Proxy Model Name:	proxy 1					
Initial Variants Group Set Na	mer proxy 1 group set					
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		Current Paramet	ers:			
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Objective Functions		Group 'FIELD'	Oil Total	01.01.2024		
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Setting custom variables for the Ensemble algorithm

Custom variables can now be added to the Ensemble algorithm. They are specified in a custom workflow (Workflows \rightarrow Available Calculations \rightarrow Property Modeling \rightarrow Ensemble \rightarrow Create Variables by Ensemble \rightarrow Add Custom Variables With Respective Workflow)

🛄 Calculations and Workflows — 🗆 🗙								
$ \underbrace{ \text{Available Calculations} } \\ \hline \text{Workflov} & \underbrace{ \ }^{+} \\ \underbrace{ \ }^{\times} \\ \underbrace{ \ }^{\times 2} \\ \underbrace{ \ }^{\text{TI}} \\ \underbrace{ \ }^{\text{II}} \\ \underbrace{ \ }^{\text{III}} \\ \underbrace{ \ }^{\text{III}} \\ \underbrace{ \ }^{\text{III}} \\ \underbrace{ \ }^{\text{III}} \\ \underbrace{ \ }^{\text{IIII}} \\ \underbrace{ \ }^{\text{IIII}} \\ \underbrace{ \ }^{\text{IIIII}} \\ \underbrace{ \ }^{IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII$	Generate Initial Ensemble Input Data							
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> Fractures	Ensemble Size: 20 Preload properties							
> Machine Learning	Suffix:							
> Geomechanics	Folder: Ensemble	Create HM Project (With Prepared Workflow To Run ES Algorithm)						
	Dynamic Model							
Test Debug Workflow Run Workflow on Cluster	Export V OX							
	Test 👌 Debug Workflow Run Workflow on Cluster	Run Workflow X Close						

Building a Probability Model

in the Objective Functions and Results tree

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- Host For Dynamics					

A probability model can now be built (the Build Probability Model button) in the Analysis tab on the basis of calculation results of some experiments if they are run in the same variable space. The variants and the objective function that will be used for building the probability model should be ticked

	×	2	le X Histogram X	Crossplot ×	Graphs ×	Stacked Plot 🗙 🗾	Analysis × 🔺 🕨 🕂
			Pareto Chart 🔤 T	ornado Diagram	Quantiles		
	^		+ Add Quantile Load Q	uantiles Settings	Save Quantiles S	Settings Build Proba	bility Model Ready
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	_		FIELD Oil Total sm3	3.93899e+06	3.71532e+06	3.38172e+06	
al	^		FIELD Water Total sm3	947450	733918	533228	
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			FIELD Gas Total sm3	3.28436e+08	2.85507e+08	2.72178e+08	
	^		FIELD Watercut fraction	0.341396	0.331528	0.311575	

is implemented for any combination of and models with the same set of variables

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O.F. Standard

A new type of objective function, Standard, has been added to help cut outliers on timesteps

Geology Designer and Model Designer

Geology Designer and Model Designer 21.4

Manually assign a trajectory to a well

the well trajectory (Import \rightarrow Well Trajectories \rightarrow User Defined Well Search)

IN Calculations Import Well Trajectories Well Trajectories From Well Path/Deviation Text Format Well Heads Update existing well trajectories or add new Well Symbols User Patterns Clear existing well trajectories and add new Copy Add existing well trajectories as new versions Translate Wells Trajectories Use for Identification: name Elongate Wells Trajectories User defined well search Create Log by Trajectory MDXYZ Input Data Type: Export Well Trajectories Minimum Curvature Method: – File Names Well Filter A All Wells Well Name File Name ...15_9-F-1_A.dev 15 9-F-1 15_9-F-1 .../15_9-F-1_B.dev Wens ...15_9-F-1_C.dev Q 15 9-F-1 Type or paste ... 15_9-F-1 15 9-F-10 Prod 15_9-F-11_PROD 15 9-F-11 A PROD X Remove Rows - Add Row 逊 **INavigator**® Add to Workflow 🖉 Clear

X Close

Apply

Multiple Grids in the 2D visualization tab

Multiple grids visualization in the 2D tab is now supported (2D tab \rightarrow Settings \rightarrow General \rightarrow Allow **Multiple Grids**)

	Cases	⇔	Settings	×	<mark> 2</mark> 2D	
やア	Geometry Objects Image: Construction of the second seco		General Grids Wells Wells Wetwork Designer Bubble Maps Polygons Horizons Synchronization Axes Layers		2D ×	+
	 Graphs Fault Lines Fault Lines Structural Models Stratigraphic Tables Stratigraphic Tables Stratigraphic Tables Stratigraphic Tables Stratigraphic Settings Aquifers Settings Fractures Fractures Geosteering Objects Rotation Point 	Ge Ge R C C C C C	Aspect Ratio	*		
	+ TI × / Fluid Properties Wells Data	Ba Oł	Synchronize Camera ckground Color: oject Selection Color:	⊡ A	llow Mu	ıltiple
	Data Analysis Graphs		Allow Multiple Grids			5
	avigator®	2	3			

Rock Flow Dynamics

Controlling the position of visualization tabs

It is now possible to enforce a uniform size upon the visualization tabs using the CTRL key







General: Workspaces

project \rightarrow View \rightarrow Workspaces... \rightarrow New State \rightarrow Enter the name \rightarrow Apply State



An option to save tab combinations in a project has been added: display all the necessary tabs in the

Preview of data exchanging results

After the objects for exchange have been select highlights the objects in the current project list
Project Data Exchanging Tool



After the objects for exchange have been selected, the user may activate the Preview option, which

highlights the objects in the current project list of objects (Project \rightarrow Project Data Exchanger \rightarrow





Highlighting of workflow items with variables

variables tooltip)



Calculations containing local variables can now be highlighted in the workflow. The highlighting is implemented via the @X icon which symbolizes the variable (Calculations and Workflows \rightarrow Show



40

Well Filters creation via Workflow

It is now possible to manage Well Filters in the workflow via Python functions. New functions allow creating and editing well filters (Custom Code \rightarrow Well Filters \rightarrow get_all_well_filters(), create_well_filter() etc.)

Well Filter		br
.add_tag (tag_class= <string>, tag=<string>)</string></string>		
.add_wells (wells= <optional<vector<wf_api_well_class< td=""><td><u>, <<<</u>s</td><td>wells_name=<ontion< td=""></ontion<></td></optional<vector<wf_api_well_class<>	<u>, <<<</u> s	wells_name= <ontion< td=""></ontion<>
.add_wells_by_sufix (prefix= <optional<string>>, postfi</optional<string>	ix	Well Name
.clear_tags ()	1	15_9-19B
.get_3d_bounds ()	2	15_9-19S
.get_tags ()	3	15_9-19_A
.get_wells ()	4	15_9-19_BT2
.has_tag (tag_class= <string>, tag=<string>) .is_empty ()</string></string>	5	15_9-19_SR
.name	6	15_9-F-1
.remove_tag (tag_class= <string>, tag=<string>)</string></string>	7	15_9-F-10_Prod
.remove_wells (wells= <optional<vector<wf_api_well_< td=""><td>-c 8</td><td>15_9-F-11_PROD</td></optional<vector<wf_api_well_<>	-c 8	15_9-F-11_PROD
<pre>create_well_filter (name=<string>, overwrite_existing= get all well filters ()</string></pre>	< 9	15_9-F-11_A_PROD
get_all_well_filters_in_folder (folder= <string>)</string>	10	15_9-F-11_B_PROD
_ get_well_filter_by_name (name= <string>)</string>	11	15_9-F-11_T2_Production
well_filter_exists (name= <string>)</string>	12	15_9-F-12_prod
	13	15_9-F-14_PROD

For example, you can create a filter based on the presence of certain refixes or postfixes in the well names

1	<pre>filter.=.create_well_filter.(name</pre>	e= Proc	duction, overwrite_existing
2	<pre>postfixes -= · ["PROD", · "Prod", · "Prod"</pre>	oductio	on",-"prod"]
5	<pre>for · i · in · postfixes:</pre>	ostfix=	=i)
			Well Name
		1	15_9-F-10_Prod
		2	15_9-F-11_PROD
	Well Filters	3	15_9-F-11_A_PROD
	✓ A Production	4	15_9-F-11_B_PROD
		5	15_9-F-11_T2_Production
		6	15_9-F-12_prod







Page Layout: add a screenshot via Workflow

added: Calculations and Workflows \rightarrow GUI \rightarrow Create \rightarrow Add Screen to Print

Calculations and Workflows	
Available Calculations	Workflow2 ~ 🕂 🕇 🚰 🚰 🗊 🍅 🍏 🅐 📕 🕨
Available Calculations Import Utilities Import Auxiliary Calculations Structural Modeling Property Modeling Dynamic Model Export Schedule GUI * Create Add Page to Print Add Screen to Print Adjust Select Show Others Fractures Machine Learning Geomechanics	Workflow2 Input variables Python Libraries I



An option to add the screenshot of the current tab into the Page layout window via a workflow has been

Add Screen to Print Print Holder: Page Layout Add To Last Page Page Number: 1			
	6,4005e+0 6,48e+0 6,4795e+0 6,4795e+0 6,478e+0 6,4775e+0 6,4775e+0 6,4776e+0		



42

Page Layout: Page, Circle, Rectangle

- Page

highlight important information: Page Layout -> Add Circle/Add Rectangle





It is now possible to create Page Layout with several pages: Page Layout \rightarrow Pages Operations \rightarrow Add

It is now possible to draw circles and rectangles in the Page Layout window. These options can be used to





43

Page Layout: Multi-page print

An advantage of this feature is that maps of any format can be printed using a simple A4 printer: Page Layout \rightarrow Pages Operations \rightarrow Use Solid Page \rightarrow Settings \rightarrow Solid Page Area





Updated Log Panel



Contents

The following options are now supported:

- A common view of the log panel with an option to search and filter messages by tags or mask is now supported for all tNavigator modules:
 Simulator, Geology Designer, Model Designer, Network Designer, PVT Designer, etc.
- Message prefixes visualization (step, day, date, time);
- Displaying information about dates and well names in error messages;
- **Clearing** the log panel from all messages;
- Changing message colors;
- Output of log messages from several modules at the same time.



Common view of the log panel for tNavigator modules

A common view of the log panel with an option to search and filter messages by tags or mask is now supported for all tNavigator modules: Simulator, Geology Designer, Model Designer, Network Designer, **PVT Designer, etc.**



🗙 🗌 Run till Step: 0	🗧 0 🖨 隆 15.05.2011 🗸						
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General				-			
- G	eology Do	esigner a	and 🚺				
-I ▼ C	Model	Designer					
		esigner	- <u>-</u>		11 Log Filtering Settings		
Axes Color	3				Select Current Filter 🛛 Log Filter 1 🛛 🗸 🕂		↓ ↑
Font Settin	ngs	~		Z scal	Activate Filtering by Tags		Activate Filtering by Mask
							Mask
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Desig	ner 📐		24,5313	0,5067	Show Message Only if All Its Tags Are Selected		
	0.48		29,5309	0,5082	Display Only Tags Present in Current Log		Hide messages
Rock Flow Dynamics (R) tNavigator PVT Designer (v21.4m-1095-g282f35e677c	1	-	Show Message Tags	0	Show messages
Access granted via Mo Done calculating Live	del Designer license. Oil (PVTO) table in Variar	t 1			Log Verbosity:		
Done calculating Dry Calculating PVT Calcu	Gas (PVDG) table in Variant lator 1 in Variant 1	: 1			Normal (recommended)		
some carculating PVI	Calcalator I in Vallant I						
					>		
		T	(i) 6	<u>}</u> 0	• •		









Message prefixes visualization in the log panel

prefixes can be changed using the REPORTFILE and REPORTSCREEN keywords (Log panel \rightarrow Right-click \rightarrow Show Timestamps/Show timesteps)

Timestamps	Timesteps								
12/17/21 11:24:36 A	t step 35 (07 APR 2012) PAV: 105.2, OIL:	450.73, GAS:	22309.69, LIQ:	454.15, INJW:	729.04, INJG:	0.00, INJO:	0.00, WCT:0.008, GOR: 4	49
12/17/21 11:24:36 A	t step 36 (07 APR 2012) Bottom hole pressure	e limit not set	for well 26. Will	use default value	of 1.013 bars.			
12/17/21 11:24:38 A	t step 36 (15 APR 2012) PAV: 105.1, OIL:	653.65, GAS:	31514.57, LIQ:	657.33, INJW:	731.33, INJG:	0.00, INJO:	0.00, WCT:0.006, GOR: 4	48
12/17/21 11:24:38 A 12/17/21 11:24:40 A	t step 37 (07 MAY 2012) PAV: 105.6, OIL:	622.76, GAS:	28425.32, LIQ:	626.39, INJW:	776.00, INJG:	0.00, INJO:	0.00, WCT:0.006, GOR: -	45
12/17/21 11:24:40 A 12/17/21 11:24:40 A	t step 37 (07 MAY 2012 t step 38 (07 MAY 2012 t step 38 (07 MAY 2012	.) ####### FINISH REPOR .) Bottom hole pressure .) Bottom hole pressure	RT N 0038 ON 07 e limit not set	.05.2012 ####### for well 40. Will	use default value	of 1.013 bars.			
12/17/21 11:24:40 A 12/17/21 11:24:42 A 12/17/21 11:24:42 A	t step 38 (07 MAY 2012 t step 38 (15 MAY 2012 t step 38 (15 MAY 2012	<pre>> PAV: 105.7, OIL: ######## FINISH REPOR</pre>	815.87, GAS: RT N 0039 ON 15	36810.21, LIQ:	820.11, INJW:	855.38, INJG:	0.00, INJO:	0.00, WCT:0.005, GOR: 4	45
12/17/21 11:24:42 A 12/17/21 11:24:44 A	t step 39 (15 MAY 2012 t step 39 (21 MAY 2012	<pre>Bottom hole pressure PAV: 105.8, OIL:</pre>	e limit not set 869.97, GAS:	for well 22. Will 38836.42, LIQ:	use default value 874.58, INJW:	of 1.013 bars. 882.71, INJG:	0.00, INJO:	0.00, WCT:0.005, GOR:	44
12/17/21 11:24:44 A 12/17/21 11:24:44 A 12/17/21 11:24:51 A	t step 40 (21 MAY 2012 t step 40 (31 MAY 2012 t step 40 (31 MAY 2012	<pre>Description Action Action Description Description</pre>	e limit not set 825.93, GAS:	for well 24. Will 36851.24, LIQ:	use default value 830.36, INJW:	of 6891.2 bars. 1049.76, INJG:	0.00, INJO:	0.00, WCT:0.005, GOR:	44
12/17/21 11:24:51 A	t step 40 (31 MAY 2012	####### FINISH REPOR	Select	All ****					
	-		Show 1	Timestamps					_
			Show 1	Timesteps					
			Show 1	Tags					
Novinotor®			Clear A	AII					
			Color S	Settings					

Graphical Interface, Geology Designer, Model Designer, Network Designer, PVT Designer 21.4

Blocks for message prefixes (step, day, date, time) are now visualized. The format settings of message









Error messages detailing

Information about dates and well names is now visualized in error messages for the keywords of the

SCHEDULE section

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F.	Definitions				2D	3D	Histog
₽	Grid Properti	es				Press	ure a
	 Calculate Press 	ed ure	Î		145	.76213	
	Satur	ation of Oil	> `		143	.89748	
	Graphs				142	.03284	
	Graph Templ	ates			140	.16820	
	Waterflood				138	.30356	
	2D Histogran	n		4			
	Fluid Propert	ies					
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rile At 29	'C:/WORK/Dla JUN 2011: E	ckoilprwo/m rror in kw.	WCLUDE/hic WCONPROD:	t_d we	eme_1 11	cch_e.i 1': BHP	is wron
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Clear All

Color Settings

Change the color of messages and clear the log panel

- All messages can now be cleaned off of the log panel (Log panel \rightarrow Right-click \rightarrow Clear All)
- The colors of messages (warnings, errors, etc.) in the log panel can now be edited

(Log panel \rightarrow Right-click \rightarrow Color Settings)

####### FINISH REPORT N 0036 ON 07.04.2012 ####### Bottom hole pressure limit not set for well 26. Will use default value of 1.013 bars. PAV: 105.1, OIL: 653.65, GAS: 31514.57, LIQ: 657.33, INDW: 731.33, INJG: ####### FINISH REPORT N 0037 ON 15.04.2012 ######## 626.39, INJW: PAV: 105.6, OIL: 622.76, GAS: 28425.32, LIQ: 776.00, INJG: ####### FINISH REPORT N 0038 ON 07.05.2012 ######## Bottom hole pressure limit not set for well 40. Will use default value of 1.013 bars. Bottom hole pressure limit not set for well 15. Will use default value of 1.013 bars. 36810.21, LIQ: PAV: 105.7, OIL: 815.87, GAS: 820.11, INJW: 855.38, INJG: ####### FINISH REPORT N 0039 ON 15.05.2012 ######## Bottom hole pressure limit not set for well 22. Will use default value of 1.013 bars. PAV: 105.8, OIL: 869.97, GAS: 38836.42, LIQ: 874.58, INJW: 882.71, INJG: ####### FINISH REPORT N 0040 ON 21.05.2012 ####### Bottom hole pressure limit not set for well 24. Will use default value of 6891.2 bars. PAV: 106.4, OIL: 825.93, GAS: 36851.24, LIQ: 830.36, INJW: 1049.76, INJG: ######## FINISH REPORT N 0041 ON 01.06.2012 ######## Bottom hole pressure limit not set for well 26. Will use default value of 6891.2 bars. PAV: 107.2, OIL: 732.98, GAS: 737.41, INJW: 1458.24. INJG: 32076.61, LIQ: ####### FINISH REPORT N 0042 ON 07.06.2012 ######## Select All Bottom hole pressure limit not set for well 27. Will use default valu Show Timestamps Show Timesteps Show Tags

Clearing the log panel from all messages

Graphical Interface, Geology Designer, Model Designer, Network Designer, PVT Designer 21.4







Log messages from several modules simultaneously

It is now possible to output log messages from several modules simultaneously. The user can now select modules whose logs will be displayed in the log panel: Geology Designer, Model Designer, PVT Designer, Well Designer or Network Designer. This option is applicable to work with integrated models in Project Manager (Project Window → Log Management)

[21:46:50]	Use C
[21:46:50]	Integ
[21:46:50]	+=======
[21:46:50]	Control In
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[21:46:50]	+===========
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[21:46:50]	Enable Fu
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[21:46:50]	+============
[21:46:50]	
[21:46:50]	Network Desig
[21:46:50]	C:/Users/
[21:46:50]	
[21:47:00]	Rock Flow Dyna
[21:47:00]	Access granted
[21:47:05]	Rock Flow Dyna
[21:47:05]	Access grante
[21:47:09]	Rock Flow Dyna
e	
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Geology Designer





Geology Designer 21.4







Restrict Mode for seismic horizons and faults

Restrict Mode



Restrict Mode has been added for visualization of seismic horizons and faults only at the intersections

with the seismic data displayed in the 3D tab (3D tab \rightarrow Settings \rightarrow Seismic Fault and Horizon \rightarrow



Color management of 2D and 3D surveys in the 2D tab

 $(2D \text{ tab} \rightarrow \text{Settings} \rightarrow \text{Seismic } 2D/3D \rightarrow \text{Color})$





Geology Designer 21.4

In the 2D and 3D seismic surveys can now be simultaneously displayed in the 2D window in different colors







Hotkeys for seismic data interpretation

- Hotkeys to work with seismic data have been added
- The following hotkeys can be used in the 3D tab:
 - enables the Move Seismic Slice optic [M]
 - opens the Interpret Seismic Surfaces menu [1]
 - [1-6] activates the corresponding tool of the menu













Hotkeys for seismic data interpretation

- Hotkeys to work with seismic data have been added
- window

Esc	~ 、	! 1	[@] 2	[#] 3	\$ 4	[%] 5	^ 6	^{&} 7	* (9	0 -	- +	=	
Tab	q	W	e e	r	t	У	u	i	0	р	{	}]	 \	Del
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Shift		Z	Х	С	V	b	n	m	< ,	> .	?		Shift	
Fn	Ctrl		Alt						Alt	Ctrl	<	\sim	>	



The combination of the left/right arrow keys with Ctrl allows moving Inlines, Crosslines and Slices by a

specified step in the Seismic tab, as well as in the 3D window for the direction selected in the Settings









Markers creation by seismic horizon

A calculation to create markers at the intersection of well trajectories with seismic horizons has been added (Markers \rightarrow Calculations \rightarrow Build Marker by Seismic Horizon)











Well symbols control for markers in the 2D tab

symbols for different horizons in the 2D tab



Well symbols can be set for markers using the numeric marker attributes, for example unique well





Interactive eraser for well logs

- Manually delete a part of a well log curve in the Well Section tab
- **Delete points or fill them with an undefined value**











Well logs mnemonics during their import

- Set a custom name for each imported well log, different from the name indicated in the file.
- **GK**) (Logs \rightarrow Calculations \rightarrow Import \rightarrow Use Global Log Mnemonics)

Import	
From LAS Format	
Assign Tags:	
Import to Folder:	
+ Las File Names	
- Preview	
Number of Lines: 100	
1774.000000 0.000000	
1774.200000 0.000000	
1774.400000 0.000000	
1774.600000 0.000000	
<	
- Options	
Ignore Empty Logs	
🖂 Use Global Log Mnemoni	cs
Choose Logs Manually	
Use for Identification:	name
Take Well ID From:	'WELL' mnemonic
Edit Null Value Manualy:	-999.25
Logs With Equal Names:	Merge
Use OEM Encoding	



May be useful when you routinely need to rename loaded well logs (e.g., Gamma Ray to GR, GAMM or







Well logs mnemonics during their import

A dictionary of log names (mnemonics) can be predefined and applied to all imported logs Settings → Well Log Mnemonics

Proje	ct	View	Settings	Files	Project Manager	r
H.	C	1 1	Unit	s Manag	jer	
			Coo	rdinate S	System Settings	
E.	Ca	ses	Seisi	mic Setti	ings	
Ö	Ge	ometry	Tem	plates		
3	Q		Resu	ult settin	gs	
		י <u>ר</u> ע	Wor	<mark>kflow B</mark> a	se Directory	
			Log	ging opt	ions	
	^{>}	LU + +	Imp	ort Well	lcons	
		↓ 12:	Well	Log Mr	emonics	
			Imp	ort User	Patterns	
			Man	age Clu	ster Connections	
	~	~	Man	age Lice	ense	

	Name in Project	Well Log Template		
1	ВК	BK,LL,LL3,LLS,LLd	Dimensionless	~
2	CALI	CALI, DS, HCAL	Alpha PS Basebala Issana	^
3	DT	AK, DT, DTC, SONI	Dimensionless	
4	GR	GAMM, GK, GR, GRC	Discrete (Auto Generated)	
5	GZ	GZ, GZKS, KS	Litho	
6	К	IK, IKA, IKR, RIK	Lithology (0/1)	
7	МВК	MBK, MLL, MSFL	Porosity	
8	MGZ	GMZ,MGZ,MINV	Res	~
9	MPZ	MNOR, MPZ, PMZ	Dimensionless	
10	NGR	HKT, NGK, NGR, NKM, NKT, NKTB, NKTS	Dimensionless	
11	PERM	KLOG,K_LOG,PERM	Permeability	
12	PHIT	PHI, PHIT, POR, PORT	Porosity	
13	RHOB	DEN, DENS, GGKB, GGKM, RHOB, RHOZ, Z	Dimensionless	
14	SP	PS,SP,SP*	Dimensionless	
	Type or paste here			
14 • A	SP Type or paste here dd Row Kemove Rows	PS,SP,SP*	Dimensionless	Cance

Set custom names or use the existing mnemonic dictionary







Water saturation logs based on the Simandoux Water saturation logs based on the Simandoux equation $Logs \rightarrow Calculations \rightarrow Water Saturation Simandoux$

$$SW_{Simandoux} = \frac{a.Rw}{2.\Phi^m} * \left(\sqrt{\left(\frac{Vsh}{Rsh}\right)^2 + \frac{4\phi^m}{a.Rw.Rt}} - \frac{Vsh}{Rsh}\right)$$

a: a constant based on lithology **m**: a constant based on lithology **phi:** the DPHI log is used Vsh: the shale volume log is used **Rt:** the formation resistivity **Rw:** the formation water resistivity (a constant obtained via local well measurement) **Rsh:** the resistivity of shale in the formation (taken from the formation resistivity at the highest Vsh value in each





well)

Geology Designer 21.4





Color filling by a Stratigraphic table

table in the object tree.

t Edit Stratigraph	ic Table - "Stra	atigraphicTable1"				×	🛄 Edit Stratigra	phic Table - "Stra	atigraphic
Zone	Litho. Zone	Geological Surface Name	Horizon	Marker	Pointset	Polygon	Zone	Litho. Zone	Geologi
Overlying F	Rocks	Carlile	Carlile	Carlile			Overlyin	ng Rocks	
CarlisleShales		KF2	KF2	KF2			CarlisleShales	Select Col	umns
MowryShales							MowryShales	Add Strati	gr. Zone
ThermonolisShales		Fall River	FallRiver	FRiver			ThermopolisSha	Insert Stra	tigr. Zone
mermopolissnales		Lakota	Lakota/Morrison	Lakota				Remove S	tratior. Zone
Jurassic							Jurassic	Set Color f	for Stratig
CrowMountain		Crow Mountain	CrowMountain	CMountain			CrowMountai	Сору	
crownountain		Red Peak	RedPeak	RedPeak			Clowindulta		-
RedPeak							RedPeak		
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		Tensleep Base	TensleepBbase	TensleepbBase					Ter
Mississipian	Carbonates	Paramant	Program	Promot			Mississipian	Carbonates	
Underlying	Rocks	Dasement	Dasement	Dasement			Underlyi	ng Rocks	E
Update Tags				C	lose	? Help	Update Tags		



Visualization of color filling between markers for all wells in the well section tab is now available. To display the color filling, a Stratigraphic Table with the required markers must be created beforehand Stratigraphic Table \rightarrow Create \rightarrow Edit Stratigraphic Table \rightarrow the Well Section tab \rightarrow check the created







Color filling by a Stratigraphic table

table in the object tree.

tN Edit Stratigraph	hic Table - "Stra	tigraphicTable1"					×	Logs	Markers	Seism
Zone	Litho. Zone	Geological Surface Name	Horizon	Marker	Pointset	Polygon			🗧 Strike_Slip	p_1
Overlying	Rocks	Carlile	Carlile	Carlile					Thrust_Sc	outh
CarlisleShales		KF2	KF2	KF2					∑ Thrust_No ∑ Strike_Slij	orth p_2
MowryShales		Fall River	FallRiver	FRiver					∑ Thrust_N ▼ Strike Sliv	orth_Brai
ThermopolisShale	5	Lakota	Lakota/Morrison	Lakota					Antitethio	c_Strike_(
Jurassic		Crow Mountain	CrowMountain	CMountain					∑ Strike_Sliµ ∑ Strike_Sliµ	р_4 p_5
CrowMountain		Red Peak	RedPeak	RedPeak					Strike_Slip	p_6 tact
RedPeak		Tensleep	Tensleep	Tensleep					KF1_Cont	tact
lensleep		Tensleep Base	TensleepBbase	TensleepbBase					Carlile	
Mississipian Underlying	Carbonates Rocks	Basement	Basement	Basement					∃ Stratigrap	phicTable
Update Tags					Close	⑦ He	lp			



Visualization of color filling between markers for all wells in the well section tab is now available. To display the color filling, a Stratigraphic Table with the required markers must be created beforehand Stratigraphic Table \rightarrow Create \rightarrow Edit Stratigraphic Table \rightarrow the Well Section tab \rightarrow check the created







Point Set filtering

Point Set by Attribute and Coordinates)

Create		Cut	Point Set	by Attribute and Coc	ordin	ates		
		Resu	lt Point S	Set: PointSet_cu	t			
Pointsets Union Point Set Cut & Merge		Sour	ce Point	Set: PointSet1				
Clear Point Set Near Faults			Use	Cut Type		Attribu	ute	Operation t
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7.88e+06	7.885e+06	7.	096+00	7,0956±00				
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7,88e+06	7,885e+06		<u>09e+00</u>	nı		neric	απ	
7,88e+06	7,885e+06		<u>09e+00</u>	nı	Im -	neric		
7,88e+06	7,885e+06		<u>09e+00</u>	nı	I m _	neric	att	
7,88e+06 500000 1700	7,885e+06		<u>09e+00</u>	nı		neric	att	ribut
7,88e+06 580000 1700	7,885e+06		<u>09e+00</u>	nı		neric	att	
7,88e+06 500000 1700	7,885e+06		<u>09e+00</u>	nu		neric	att 1700	
7,88e+06 580000 1700	7,885e+06		<u>09e+00</u>	nu		neric	att	nbut

A calculation titled Cut Point Set by Attribute and Coordinates has been added. It allows filtering points







Flip 2D-Maps and Horizons calculation

Calculations	- 🗆 X	
 Calculator Create Transformations Horizon Adjustment to Mark Horizon Adjustment to Point Pull Up Horizon to Marker Logic Operations Crop Horizon by Polygon Smooth 	Flip Horizon Morizon: Bot By I By J ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	
Flip Delete Blank Lines of Horizon Local Horizon Update Clear Horizon Near Faults Export	 Image: Second state of the secon	



For Horizons and 2D-Maps, a new calculation has been added: Flip. Horizons and 2D-Maps can be

flipped along the I and/or J directions (Horizons/2D-Maps \rightarrow Calculations \rightarrow Transformations \rightarrow Flip)





Fault QC: an interactive tool

An interactive tool for quality control of fault creation has been added: Fault QC. It offers an interactive window, which shows the faults displayed in the visualization window at the moment and having possible errors in geometry (the 3D tab \rightarrow Right toolbar)



Geology Designer 21.4

		View	Object #1	Object #2	Edit	Description	Comment	Verifie
5	\wedge	۲	F1_N	F2_E		Crossing faults		No No
7	Δ	۲	F1_N	F2_N1		Crossing faults		□ No
3	Δ	۲	F1_N	F2_W		Crossing faults		□ No
9	Δ	۲	F1_N	F3_E		Crossing faults		□ No
10	Δ	۲	F1_N	F3_W_N		Crossing faults		□ No
11	Δ	۲	F1_N	F4_E		Crossing faults		□ No
12	Δ	۲	F1_N	F4_W		Crossing faults		□ No
13	Δ	۲	F1_N	F5_E		Crossing faults	ОК	✓ Yes
4	Δ	۲	F1_N	F5_W		Crossing faults	ОК	✓ Yes
5	\wedge		F1_S	F1_W_P1		Crossing faults	Edited	✓ Yes
6	Δ	۲	F1_S	F2_S		Crossing faults	Edited	✓ Yes
7	\wedge	QD	F1_S	F3_S		Crossing faults		□ No
18	Δ		F1_S	F3_W_S		Crossing faults		□ No
19	Δ		F1_S	F4_W		Crossing faults		□ No
0	Δ		F1_S	F5_W		Crossing faults	ОК	✓ Yes
1	Δ		F1_Sal_N	F1_Sal_S		Crossing faults		□ No
2	Δ		F1_Sal_N	F1_W_P2S		Crossing faults	Edited	✓ Yes
3	Δ		F1_Sal_N	F2_W		Crossing faults		□ No
4	Δ		F1_Sal_S	F1_W_P2S		Crossing faults		□ No
5	Δ		F1_Sal_S	F2_W		Crossing faults		No No
5	Δ		F1_W_P1	F1_W_P2S		Crossing faults	ОК	✓ Yes
7	Δ		F1_W_P1	F9_E		Crossing faults	Edited	✓ Yes
8	Δ		F1_W_P2N	F1_W_P2S		Crossing faults	ОК	✓ Yes
9	Δ		F2_Em_C	F3_E		Crossing faults	ОК	✓ Yes
0	Δ		F2_N1	F2_N2		Crossing faults	Edited	✓ Yes
31	Δ		F3_W_N	F3_W_S		Crossing faults		□ No
32	Δ		F3_W_S	F6_W		Crossing faults		□ No
33	Δ		F4_W	F6_W		Crossing faults		□ No
4	Δ		F4_W	F7_W		Crossing faults		□ No
5	Δ		F5_W	F7_W		Crossing faults		□ No
6			F6_W			Inverted sticks		□ No
7			F7_W			Inverted sticks		□ No
8			F9_E			Inverted sticks		□ No
39			F1_W P1			Bent sticks		□ No



Fault QC: an interactive tool

		View	Object #1	Obje	ct #2	Edit	Description	Comment	
33		۲	F4_W	F6_W			Crossing faults		E
34	\triangle	۲	F4_W	F7_W			Crossing faults	ок	Ŀ
35	\triangle	۲	F5_W	F7_W			Crossing faults	Edited	6
36	\triangle	۲	F6_W				Inverted sticks		
37	\triangle	۲	F7_W				Inverted sticks		E
38	\triangle	۲	F9_E				Inverted sticks		
39		۲	F1_W_P1				Bent sticks	Edited	ŀ
	_						Ċ	Update 🗙	
<u>tn</u>	Trunca	ate Mult	tiple Faults			-	<u></u>	Jpdate X	
<u>tn</u> Tru	Trunca	ate Mult	tiple Faults Table:			-	2 1	Jpdate X	
tn Tru	Trunca	ate Mult on Rules Result	tiple Faults Table: Fault Source	Minor Fault	Source	Major F	d I ault	Jpdate X	
<u>tn</u>	Trunca uncatio	ate Mult on Rules Result ult1	tiple Faults Table: Fault Source F7_W	Minor Fault	Source F5_W	Major F	d I ault Right	Jpdate X	



Depending on the indicated problem, the user is prompted to open the interactive faults editing tool or

the truncation rules table. After verification, the Verified mark is set

	tn Edit Fault
	🗆 Structural Model: 🚰
	Fault: F1_W_P1
	Edit Fault Edit Fault Lines
	うぐ
-	Add Border Stick
	New Stick: Horizontally 💌 From First 💌 Add
	Length to Calculate Direction: 1
	Extend by Length: 1
	C Connect to Nearest Fault Connect to Stick
	Selected Sticks
	Delete Insert Clear
	Control Size:
	Do Not Use Fixed Control Size
	Apply Changes When the Mouse is Released
	Move Whole Stick
	C Along Stick
	C Along Fault Surface
	C Perpendicular to Fault
	In Arbitrary Direction
	✓ Use Action Radius 100





DFN: Create DFN new options

The Create DFN calculation has been significantly redesigned. The user can now fully control the fractures that influence the distribution and concentration of fractures within the horizon: Geometry

Objects \rightarrow **DFN** \rightarrow **Create DFN**

Fracture Location Parameters Concentration: 100	Use Curva Horiz
- Horizon Parameters	
Use Curvature by Horizon Weight: 0.1	
- Faults Parameters	
Use Distance to Faults Weight: 0.1	
Use Distance to Faults Zero Displacement Points Weight: 0.1	
Use Faults Attributes Weight: 0.1 Reference Faults	Use Dist Fau
Add Row Remove Rows Autodetect Property Parameters	
Use Property Weight: 0.1	
DFN Probability Property: Property1	







DFN: Create DFN by Faults new options

In the Create DFN by Faults calculation, additional settings of fracture position control have been added, namely: relative dip azimuth and relative dip azimuth deviation: Geometry Objects \rightarrow DFN \rightarrow Create DFN

by Faults

Calculations								×
Create DFN	Crea	te DFN b	y Faults					*
Create DFN by Faults	DFN:	:		DFN2				-
Merge DFN		l la a		D	- F			
Shift DEN by Vector		Use		Γ.(eference Faults			
Shire Driv by vector			F11					
	2		F13					×
	+/	Add Row	🗙 Remov	e Rows			Auto	detect
	Fra	cture Sp	ecification					
	Nur	mber of F	Fractures:	200				-
	Nur	mber of s	sides:	4				
	Mir	nimum si	de length, m:	50				
	Max	ximum s	ide length, m:	150				
	Elor	ngation F	Ratio:	4				+
	Top I	- Horizon	~	Uorizon1				
		Horizon:						
	Botto	om Horiz	ion: 🕿 🗌	Horizon2				
	Fra	cture Ori	ientation					
	Orie	entation	Туре:		Relative to Faul	ts		\sim
	Rela	ative Dip	Angle, deg:		45			
	Rela	ative Dip	Angle Deviati	on, deg:	20			
	Rela	ative Dip	Azimuth, deg	:	0			
	Rela	ative Dip	Azimuth Devi	ation, deg:	20			
	Dista	nce To F	ault, m: 100					
	Rand	dom Seed	: 1					+
	⊛							
		Clear	Add to V	Norkflow	Appl		(Close	0
		Cical	Add to v	- onknow	Abbi		V CIUSE	$\overline{\mathbf{U}}$











DFN: Stereonet and Rose Diagram

characterized not only by an azimuth (direction), but also by a slope.



In the list of available windows and tabs, a new object has been introduced: Stereonet/Rose Diagram. A Rose diagram displays objects that have an azimuth, while Stereonet describes 3D objects which are











Controlling the priority of input data when creating Structural Model horizons

Horizons of Structural Model \rightarrow Interpolation Priority)



In the Extended Build Horizons of Structural Model calculation, an option to set the input data priority to control the degree of their influence on the result has been added. This allows some input data a greater degree of influence on the resulting horizon (Structural Models \rightarrow Horizons \rightarrow Extended Build

					—		×
o Structural Model	Extended	Build Hori	zons of Structural M	lodel			*
Horizons of Structural Model	dt	🖌 Struc	turalModel1				록┦
ies by Structural Model Horizons	:	🔏 Horiz	ons				
	: Table:	Strati	igraphicTable1				
	rpolation	<u>A'</u> Parameters					
	ipolacioni	ananneeers					
	<u>.</u>			- T			
	Horizon	Rank	Horizon Type	Source Horizon:		ρ1 🔻	
		1	Conformable 🔻	Interpolation Priorit	y: Low	_	
		1	Conformable	Source Marker:	Mediur	n	
	paste			Interpolation Priorit	y: High		┛║
				Source Pointset:	Poi	n+C 🔻	-









Fault Extension in a Structural Model

In the calculations Add faults to the structural model and Add Multiple Input Faults to the Structural Model, an option titled Extend Faults to Model Box Polygon has been added. (Structural Models \rightarrow Faults \rightarrow Calculations)

Calculations				- 🗆	\times
Add Faults to Structural Model	Add Faults to St	ructural Model			*
Add Multiple Input Faults to Structural Model	Structural Mode	el: 🚰 Structura	Model1		-
	-Faults				
	 Extend Stru Interpolation 	ictural Faults to Z on Parameters of	Borders Structural Faults Straightening	9	
	Use	Fault	Connection Proximity, m	Structural	1
	1 🗹	Fault_1	0		
	Туре				
		1	1		
	Add Row	Remove Ro	ows Polygon	Auto	▶ detect
	 Add Row Extend Fault Distance to E 	X Remove Rost to Model Box Postend, m: <u>10000</u>	olygon	Auto	▶ detect
- Extend Faults to Model Box Po	 Add Row Extend Fault Distance to E 	X Remove Ro s to Model Box P xtend, m: 10000	Polygon	Auto	detect
 Extend Faults to Model Box Po Distance to Extend, m: 10000 	 Add Row Extend Fault Distance to E 	Remove Ro s to Model Box P xtend, m: <u>10000</u>	ows Polygon	Auto	▶ detect








Coordination of a structural faults intersection

In the calculations Create Grid by Point Sets and Faults and Create Grid by Horizons and Faults, an option titled Intersect Structural Faults Along Sticks has been added. During the calculation, this option alters the intersecting structural faults so that they intersect via a common stick (3D-Grids \rightarrow Calculations \rightarrow Create Grid by Point Sets and Faults/Create Grid by Horizons and Faults \rightarrow Advanced Settings)

Grid Grid and Calculated Results Create Grid by Horizons Create Grid by Horizons Create Grid by Point Sets & Faults Create Grid by Point Sets & Faults Create Grid by Structural Model Create Grid by Structural Model Create Fine Grid (Downscaling) Create Extended Grid Grids Merging DEBUG Space Transform 3D Using Tetrahe We take distructural Faults to Z Borders Simplify Faults According Grid Detail Create Structural Faults Along Sticks Extended Segments Property: Segments_ext Preprocessing of High Amplitude Structures	Calculations	- L X
Create Coarse Grid (Upscaling) Create Fine Grid (Downscaling) Create Extended Grid Grids Merging DEBUG Space Transform 3D Using Tetrahe ↓ 1 Top1 Zone1 Proportional * 20 ↓ 2 Top3 Fixtend Structural Faults to Z Borders Simplify Faults According Grid Detail ↓ Intersect Structural Faults Along Sticks Extended Segments Property: Segments_ext Preprocessing of High Amplitude Structures ↓	Grid Grid and Calculated Results Create Grid Create Grid by Horizons Create Grid by Point Sets & Faults Create Grid by Horizons & Faults Create Grid by Structural Model	Grid: Horizons Vuse Top Layering Horizon as Base One for Previous Zone Specify Minimum Zone Thickness by Zone Proportions Table: Polygons Area
 Extend Structural Faults to Z Borders Simplify Faults According Grid Detail Intersect Structural Faults Along Sticks Extended Segments Property: Segments_ext Preprocessing of High Amplitude Structures 	Create Coarse Grid (Upscaling) Create Fine Grid (Downscaling) Create Extended Grid Grids Merging DEBUG Space Transform 3D Using Tetrahe	▲ Horizon Zone Partition Type Layer Count/F ▲ 1 Top1 Zone1 Proportional ▼ 20 ▲ 2 Top3 Top3 Top3 Top3
		 Extend Structural Faults to Z Borders Simplify Faults According Grid Detail Intersect Structural Faults Along Sticks Extended Segments Property: Segments_ext Preprocessing of High Amplitude Structures







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New Object: Grid Fault

comparison with the original faults (Geometry Objects \rightarrow 3D-Grids \rightarrow Grid Faults)

Create Grid by Point Sets & Faults	
Create Grid by Horizons & Faults	
Calculations – 🗆 X	
Create Fault on Grid Grid Intersection with Fault Surface	
Create Multiple Fault on Grid Grid: main_grid Split Fault on Grid by Property Fault: Fault:	
Fault on Grid:	
Created automatically as a	
result of the calculation	
C 🛱 3D-Grids	
🗄 🔿 🛱 Main_grid	
E O Properties	
🖹 🔽 🔪 Grid Faults	
🔽 📉 FaultonGrid1	
TNavigator ® Grid Horizons	

A new type of object has been added: Grid Faults. It represents a surface and is necessary to understand how the fault is embedded in the 3D model. It allows quality control of the created fault model and visual







Faults on Grid: Split by Property

Split Fault on Grid by Property





An option to split a Faults on Grid object into segments with the help of a discrete property has been added. Each new segment of the initial object is the intersection of the fault surface with the grid cells within the limits of the appropriate discrete zone (Geometry Objects \rightarrow Properties \rightarrow Faults on Grid \rightarrow

Import Fault Grid from Model	Split Fault on Grid by Property
Create Fault on Grid Create Multiple Fault on Grid	Grid: Grid1
Split Fault on Grid by Property	Fault on Grid: 🚽 FaultonGrid1
	Discrete Property: 🗇 Property1
	Prefix:
	R
	Clear Add to Workflow Apply
	🗹 🖿 Faults on Grid
	Faults on Grid
	Faults on Grid Faults on Grid FaultonGrid1 FaultonGrid1_1
	Faults on Grid FaultonGrid1 FaultonGrid1_1 FaultonGrid1_2 FaultonGrid1_2
	 Faults on Grid FaultonGrid1 FaultonGrid1_1 FaultonGrid1_2 FaultonGrid1_3
	 Faults on Grid FaultonGrid1 FaultonGrid1_1 FaultonGrid1_2 FaultonGrid1_3 FaultonGrid1_4
	 Faults on Grid FaultonGrid1 FaultonGrid1_1 FaultonGrid1_2 FaultonGrid1_3 FaultonGrid1_4 FaultonGrid1_5
	 Faults on Grid FaultonGrid1 FaultonGrid1_1 FaultonGrid1_2 FaultonGrid1_3 FaultonGrid1_4 FaultonGrid1_5 FaultonGrid1_6
	 Faults on Grid FaultonGrid1 FaultonGrid1_1 FaultonGrid1_2 FaultonGrid1_3 FaultonGrid1_4 FaultonGrid1_5 FaultonGrid1_6 FaultonGrid1_7

FaultonGrid1_9

FaultonGrid1_10







Geobody creation based on point sets or polygons

(Calculations \rightarrow Create \rightarrow Create Geobody by Point Set/Fence Polygons)



An option for automatic creation of geobodies based on point sets or fence polygons has been added





Geobody surface editing

• A new tool for interactive editing of geobodies' triangulated surfaces in 3D has been added (3D \rightarrow Edit **Triangulated Surface)** V

The editing is performed via selection of one or more vertices of the surface and their further dragging

Editing Method Edit Vertices જર 🔆 0 Change Coords X: Triangulated Surface/Geobody Component: Geobody5_Component1

Moving a vertex in space. It is possible to set a radius of action











Create properties by geobodies

An option to create properties by geobodies has been added. In this calculation, there are two types of settings available for the user: either each cell of the property will reflect this cell's volume fraction located within the modeled geobody, or each cell located within the geobody will be assigned one user-defined value, and the cells outside will be assigned another value





Ζ

 $(3D-Grids \rightarrow Properties \rightarrow Calculations \rightarrow Create \rightarrow Create Build Property by Geobody)$







Import/export of triangulated surfaces and geobodies

been added (Geobodies/Triangulated surfaces \rightarrow Calculations \rightarrow Import/Export)



An option for the import/export of triangulated surfaces and geobodies in .tsurf, .ply, .dxf formats has



Contacts filtering based on discrete properties

An option for contacts filtering based on discreased and a second contacts filtering based on discreased allows visualization of the contact for every single





An option for contacts filtering based on discrete properties (Zones/Regions) has been added, which

allows visualization of the contact for every single layer or deposit (Settings \rightarrow Contacts \rightarrow Discrete



Point set and polygon creation on a Cross-Section

Tools for point set and polygon creation and editing have been implemented for the Cross-Section tab. These tools are important for raster cross-sections digitizing, seismic data, manual corrections during conceptual modeling or geological cross-section design (Cross-Sections -> Edit Point Sets/Edit

cur	Polygons					×	
	4 4	🛹 ݮ 🗘	×		5	Ċ ?	
	Polygon: 5					~	
	Change Coords: >	6 513,12239	Y:	511,30381	Z: 0]
	Remove Node an	d part of the Edge	2			2	
	Apply to all comp	onents					
	Add new compo	nent					
	Put into folder:					~	1
	Use generic name	2					
			E Cros	ss- ections ×	<u></u> 2D × €	Ĵ3D× +	
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			200				
400		900 X	400		3456565468	//////////////////////////////////////	
200	300 400 500 600 7	0 800					
100 21	00		600				
500							
TNovig	Intor®						
Rock Flow Dynamics	Jalui	l	800		큠큠훕(210181848 호)··	사진성전한 전 대대신원이	







Contact visualization in the 2D tab

reporting materials (the 2D Tab)





In the 2D visualization tab, you can now display contacts as contours. The option helps to prepare







Facies Probability in Data Analysis

A new tab titled Facies Probability is now available in Data Analysis, allowing analysis and, if instance, a seismic attribute)





necessary, editing of the dependence between a discrete property (facies) and a continuous one (for

	Later, this distribution may inter	be used for discrete propolation
e+06 8.39e+06	Property Interpolation (Zones, Regions)	
	Input	Output
	Grid: main_grid 🔻	Property: Property3
	Blocked Wells:	Kriging Variance: Property1
	Do not use Blocked Wells in SGS (Unconditional Simulation)	
	Statistics: Statistics	
	Use Settings From Data Analysis	
	Use the following settings in interpolation	Apply changes to all zone
	Objective Function:	Secondary Attribute
	Secondary Attribute	Property2
	Take conditional distribution from Data Anala	sis
e+06 8.39e+06	Method: Kriging 🗸	
	Variogram Kriging Cokriging Distril	oution Trend
	Take from Data Analysis	Take from











Geosteering



Contents

The following options have been added:

- Azimuthal images interpretation during well navigation.
- Automatic calculation of the gap between the drilling bit and the receiver where no geophysical data are present (no logs values).
- Setting a custom location for well names in the Cross-Section panel in the Geosteering tab
- Generation of synthetic images for the drilled well based on the reference well data.



Geosteering: Images interpretation

















Geosteering: Images interpretation

An option for azimuthal images interpretation during well navigation has been added (Geosteering \rightarrow display the required image \rightarrow Right Toolbar \rightarrow click the Add Image Interpretation button)

	r						
×			P	arameter			Value
		TST				200.00, m	
		TVD	Γ			Markers are	not set
		Тор	horizon inc	clination ar	ngle	-0.03, deg	
		Last	non-null lo	og value		No log selec	ted
		Incli	nation ang	le deviatio	n	-1.06, deg	
		Azim	uthal angl	le deviatio	ו	-0.05, deg	
		Verti	cal deviatio	on		-2.8, m	
		Rem	aining dist	ance to do	wnhole	0.00, m	
		Curr	ent drilling	distance		802.00, m	
		Curr	ent drilling	MD (TVDS	S)	3917.00 (235	6.82), m
		Curr	ent drilling	inclinatio	n	88.94, deg	
		Plan	ned drilling	g distance		802.00, m	
					Defere		
					Refere	nce_wen : 64	
		TVDSS,	6	GR			GGKP /
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			X TST TVDI Top I Last Inclin Azim Vertion Rem Curro Curro Curro Plant SPEC SPEC SPEC SPEC SPEC	X P TST TVDT Top horizon inc Last non-null lu Inclination ang Azimuthal ang Vertical deviation Remaining dist Current drilling Current drilling Current drilling Current drilling P TST Top horizon inc Last non-null lu Inclination ang Vertical deviation Remaining dist Current drilling Current drilling Current drilling Planned drilling 1.0 FER FER FER FER FER FER	X Parameter TST TVDT Top horizon inclination ar Last non-null log value Inclination angle deviation Azimuthal angle deviation Vertical deviation Remaining distance to do Current drilling MD (TVDS) Current drilling inclination Planned drilling distance Inclination Vertical deviation Remaining distance to do Current drilling distance Current drilling distance Vertical deviation Planned drilling distance Vertical deviation Planned drilling distance Vertical deviation Planned drilling distance Vertical deviation Vertical deviation Vertical deviation Planned drilling distance Vertical deviation Vertical deviation Vertical deviation Vertical deviation <td>Parameter TST TVDT Top horizon inclination angle Last non-null log value Inclination angle deviation Azimuthal angle deviation Vertical deviation Remaining distance to downhole Current drilling distance Current drilling distance Refere 1</td> <td>Parameter TST 200.00, m TVDT Markers are Top horizon inclination angle -0.03, deg Last non-null log value No log select Inclination angle deviation -1.06, deg Azimuthal angle deviation -0.05, deg Vertical deviation -2.8, m Remaining distance to downhole 0.00, m Current drilling distance 802.00, m Current drilling distance 802.00, m Planned drilling distance 802.00, m Reference_well 1:64 1:64 """ """ Senditors</td>	Parameter TST TVDT Top horizon inclination angle Last non-null log value Inclination angle deviation Azimuthal angle deviation Vertical deviation Remaining distance to downhole Current drilling distance Current drilling distance Refere 1	Parameter TST 200.00, m TVDT Markers are Top horizon inclination angle -0.03, deg Last non-null log value No log select Inclination angle deviation -1.06, deg Azimuthal angle deviation -0.05, deg Vertical deviation -2.8, m Remaining distance to downhole 0.00, m Current drilling distance 802.00, m Current drilling distance 802.00, m Planned drilling distance 802.00, m Reference_well 1:64 1:64 """ """ Senditors

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Geosteering: Synthetic images creation

Synthetic Image) Value Parameter

🔅 Settings	×
Layout	
Style	
Synthetic Borehole Image	
General	
Comments	
Editing	
Wells	
> Well lemplates Manhara Dania stimus	
Markers Projections	
Synchronization	
Enable Synthetic Borehole Image	
Well Log for Synthetic Image:	
≿ GGKP	•
Step along X:	
0,2	* *
Measures Count:	
4	-







An option to generate synthetic images for the drilled well based on the reference well data has been

added (Settings \rightarrow Synthetic Borehole Image \rightarrow Enable Synthetic Borehole Image \rightarrow Well Log for







Geosteering: Offset intervals calculation

An option for automatic calculation of the distance between the drilling bit and the receiver has been added (Geosteering \rightarrow Right Toolbar \rightarrow Open Tables \rightarrow LWD Offsets)

#		
~Version information		
VERS. 2.0 :		
WRAP. NO :		
#		
STRT .M 3058.900000	:	
STOP .м 3917.500000	:	
STEP .m 0 :		
NULL999.250000	:	
COMP. : COMPANY	1 . WELL	
FID. : FTFID	II. WLLL	
LOC. : LOCATION	I	
SRVC. : SERVICE	COMPANY	
DATE. : DATE		
PROV. : PROVINCE		
UWI. : UNIQUE W		
AFI AFI NOMD		
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DEPT .M	: DEPTH	
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GK . : GK #		
n		
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3911.400000	-999.250000	35.380000
3911.500000	-999.250000	35.380000
3911.600000	-999.250000	35.380000
3911 700000	-999 250000	35 380000
3911.800000	-999.250000	35.380000
3911.900000	-999.250000	-999.250000
3912.000000	-999.250000	-999.250000
3912.100000	-999.250000	-999.250000
3912 200000	-999 250000	-999 250000
3312.200000	- , , , . 2 , 0000	- , , , . 2 , 0000
2017 20000	000 250000	000 350000
2311.200000	-999.250000	-999.250000
391/.400000	-999.250000	-999.250000
3917.500000	-999.250000	-999.250000





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tn	Tables					
Co	Tables mments	Angles	; LWD Offsets	An	nplitudes	
Co	Tables mments Nar	Angles	; LWD Offsets Last MD, m	An	nplitudes	Offset, m

Offset = Current drilling MD – MD of the last non-null log value = <u>3917.0 – 3911.8 = 5.2m</u>





Model Designer





Model Designer 21.4





Change the path to loaded calculation results

name \rightarrow RMB on the result \rightarrow Replace Path to Existing Result)

			✓ ↑
В	🖆 🥕 🕑 🔎 🕨	🕨 📔 🗙 🗌 Run till Step: 0 🖨 0	
E.	Cases		
⇔	Name	Status	
P	BIACK OIL DE	мо	SUMMARY
	🕀 imported_BL	ACK_OIL_DEMO Calculated (77/77 steps)	
		T Rename	
•		Replace path to existing result	
	+ × TI < 🔻	× Remove	· · · · · · · · · · · · · · · · · · ·
	Geometry Objects	View results	
	Fluid Properties	i View Log	
	Wells Data	Continue calculations	
	Data Analysis	Show Containing Folder	
	Graphs	▲ Export result	



It is now possible to change the path to loaded calculation results. It allows using calculation results of other users (including for restarts) after copying the project to another folder (Cases \rightarrow DynamicModel





Optimizing the output size of several models with the same grids during initialization

Properties to Common Folder)

Cases	Properties	; x	🛆 Jobs 🗙	+					
Name	Definition	Static	Aquifers	Fluids	Faults	Writing of Resu	lts Restart	Schedule	F
Dunamic Model	Current grid 🛱	BLAC	K_OIL_DEMO				🔻 Grid g	eometry type f	or
✓ BLACK_OIL_DEMO	Description		Keywo	ord Com	ponent	Grid	Property	Constant	N
😥 imported_BLACK_OIL_DENO	✓ Basic grid	propertie	s						
N BLACK_OIL_DEMO_base	Active	grid bloc	ks ACTN	UM	l	BLACK_OIL_DEMO	ACTNUM		Si
✓	Net to	Gross Rat	tio NTG			BLACK OIL DEMO	Net to Gross Ra	tio	Si
BLACK_OIL_DEMO_PERM_MOD	Permea	ability alo	ong X PERM	X		BLACK_OIL_DEMO	PERMX_MOD		Si
	Permea	ability alo	DERM	Υ 7		BLACK_OIL_DEMO	PERMY_MOD		Si
	Permea			2		BLACK OIL DEMO	PERIVIZ IVIOD		Si
	 v asic regio 	ns	PORO			DEACK_OIE_DEMIO	Porosity		5
	Equilib	ration Re	gions EQLN	UM		BLACK_OIL_DEMO	EQLNUM		Si
	Puid-ir	n-place re	egions FIPFAl	ULT		BLACK_OIL_DEMO	FIPFAULT		Si
<	Fluid-in	n-pla							
+ × TI < 🔻	Saturat	gions on F	Resu	It sett	ings				
Geometry Objects		N							
			Result F	older					
Fluid Properties			🛛 Use d	efault					
Wells Data									
Data Analysis									
		_							
Graphs	+ × /	-] Dump	dyna	mic n	nodel			
			Dump	Grid	and P	roperties to	Commo	n Folder	
			-			- F			
			C. (DECL	II TC					

The grid properties and data of models can now be uploaded to a specified folder (in this case, the properties without changes will not be uploaded) (Settings \rightarrow Result Settings \rightarrow Dump Grid and

		« Local Disk (C:) > RESULTS	ට 🔎 Search	RESULTS
Project Manager Cases	^	Name	Date modified	Туре
r export: Coord/ZCorn ~		BLACK_OIL_DEMO_base.grdecl	20.12.2021 12:35	GRDECL File
Matrix/Fracture		BLACK_OIL_DEMO_base_ACTNUM	20.12.2021 12:35	INC File
ingle poro model		BLACK_OIL_DEMO_base_EQLNUM	20.12.2021 12:35	INC File
ingle poro model		BLACK_OIL_DEMO_base_FIPFAULT	20.12.2021 12:35	INC File
ingle poro model ingle poro model		BLACK_OIL_DEMO_base_FIPNUM	20.12.2021 12:35	INC File
ingle poro model		BLACK_OIL_DEMO_base_NTG	20.12.2021 12:35	INC File
ingle poro model ingle poro model		Only the propert be uploaded for	ties with c the modi	hanges wil fied model
		BLACK_OIL_DEMO_base_SATNUM	20.12.2021 12:35	INC File
		BLACK_OIL_DEMO_PERM_MOD_PERMX	20.12.2021 12:36	INC File
		BLACK_OIL_DEMO_PERM_MOD_PERMY	20.12.2021 12:36	INC File
-		BLACK_OIL_DEMO_PERM_MOD_PERMZ	20.12.2021 12:36	INC File
		<		>
OK Cancel				



91

Optimizing the output size of several models with the same grids during export

models that have one base model (Cases \rightarrow RMB on DynamicModel name \rightarrow Export Model \rightarrow Export **Only Changed Grid and Properties to Separate Files**)

Proj	Project View Settings Files Project Manager Reports Help									
Ħ	🔄 🌽 👌 👄 🕨 💵 🗙 🗆 Ru	in till Step: 0	÷ 0 ÷ 🕅	15.05.2011 🗸 📍						
	Cases	🗘 Propert	ies 🗙 🛆	Jobs × +						
やア	Name > DynamicModel ✓ BLACK_OIL_DEMO © imported_BLACK_OIL_DEMO	Definition Current grid Description & Basic gri	Static BL d proper	The per are m	rmeability grid pro odified in the dupli	pertie icated				
	BLACK_OIL_DEMO_base BLACK_OIL_DEMO_PERM_MOD BLACK_OIL_DEMO_PERM_MOD	Activ Net 1 Perm Perm	ve grid b to Gross Ratio neability along neability along		SION OT LINE DASE MO BLACK OIL DEMO Net to Gross Ratio BLACK_OIL_DEMO PERMX_MOD BLACK_OIL_DEMO PERMY_MOD BLACK_OIL_DEMO PERMY_MOD	Single Single Single Single				
	<	Poro Basic reg Equi Fluid Fluid PVT- Satu	sity Jons libration Regio l-in-place regi l-in-place regi	PORO ons EQLNUM ons FIPFAULT ons FIPNUM PVTNUM	BLACK_OIL_DEMO Porosity BLACK_OIL_DEMO EQLNUM BLACK_OIL_DEMO FIPFAULT BLACK_OIL_DEMO FIPNUM BLACK_OIL_DEMO PVTNUM	Single Single Single Single Single				
	Geometry Objects Fluid Properties Wells Data		Model Fold Model Nam	er: C:/EXPORT	DEMO_PERM_MOD					
	Data Analysis Graphs	+ × 2	Prepare Export G	Model for MR irid to a Separate	File					
	Rock Flow Dynamics		Export P Export C Export R	roperties to Sepa Only Changed Gri esults	arate Files id and Properties to Separate Files	ОК Х				

It is now possible to optimize the size of the output of included files for different cases of simulation







Polymer injection

- The following fluid properties associated with t (Fluid Properties → EOR; Cases → Static)
 - PLYELVSC is for the elongational viscosity multiplier as a function of the polymer concentration in a table
 - PLYELVSV is for the elongational viscosity multiplier as a function of the stream velocity
- PLYELVMAXA, PLYELVSVA are for the elongational viscosity multiplier in analytical form
- PLYDHFLF is for the temperature-dependent polymer half-life period
- PLYSHEARA is for the shear viscosity multiplier
- PLYKRRF: rock permeability for the purposes of polymer calculation is now supported
- PLYSHLOG is for the logarithmic law of the dependence of the viscosity multiplier on the flow velocity



The following fluid properties associated with the analytical model of polymer injection are now supported



Add More Properties







Correlations for polymer properties

It is now possible to set polymer half-life period (PLYDHFLF) versus temperature as a correlation (Fluid Properties \rightarrow EOR)









supported: tabular or via a correlation formula





Logs in RFT binary format

Import of Logs in RFT binary format is now supported (Geometry Objects \rightarrow Logs \rightarrow Import \rightarrow From **RFT Format (binary)**

Proje	ct View Settings Files Project Manager R	Reports Help	
H	🔓 🥕 🖰 💵 🗙 🗆 Run till Step: 🕻	0 ≑ 0 ≑ N 0000 - 01.01.2010 0:00 🗸 💽 📍 👘 👘	1 1 1
E.	Cases	Settings X	ross-Section
₽	Geometry Objects	General Vells Calculations	
7		Network D Import > Bubble Ma Import Checkshots	Import
	Mankers	Synchroniz Calculator Axes > Create	From RFT F
	123 Wells Attributes	Layers Copy Log Transformations Calculations	From RFT F
	↓ Logs	General Setting Export Image: Concurations General Setting Export Image: Concurations Image:	Production From WITS
	Borehole Images Core Sample Images		
	Comment Logs	Rotate Import of Logs	
	Vell Test Info Seismic ✓	Auto Adjust S	
	+ TI × 🖌	Show Com	
	Fluid Properties		+ Add
	Wells Data	Scale: 1	٩
	Data Analysis	Svnchroniz	🖉 Clear
	Graphs		









BlockedWells calculator

calculator (Geometry Objects \rightarrow BlockedWells \rightarrow Calculations \rightarrow Calculator)





It is now possible to work with dynamic model data using arithmetic operations in the BlockedWells

ic × ≢ Cross-Sections × ⊞ Wells	Table \times 4 Well Sectio 4 $+$ 1	
07		
Calculations	— 🗆	×
Create Blocked Wells	Calculator	*
Create Blocked Wells by Property	Grid: BLACK_OIL_DEMO (Dynamic Model)	~
Create Discrete Blocked Wells by	Result Blocked Wells: AB BlockedWells3	-
Create Blocked Wells by Connec	Well Filter: All Wells	$\overline{}$
Create Blocked Wells by Connec Normality Test	if(BlockedWells2>1,1,0)	
 Compatibility Variants 		
	V A BLACK_OIL_DEMO (Dynamic Model)	^
	✓ ∰ BlockedWells	- 18
	BlockedWells1	- 11
	自創 BlockedWells2	- 11
	BlockedWells3	- 10
	Hesults (BLACK_OIL_DEMO: result)	~
	Operators 👻 Functions	
	Geometry Constants	•
	\odot	
	✓ Clear → Add to Workflow	se (?)





Load graphs with arbitrary dates

It is now possible to load graphs with arbitrary dates (which may differ from those set in the model)

(Graphs \rightarrow Graphs Templates \rightarrow Load Graphs)







)uai	ntiles ×	CDF ×	P _{fx} Proxy me	odels ×	🖏 Drainage Table 🗙		+ ۱						
			BLACK_	OIL_DEMC '3'):result	^							
essure, pars	01.07.2013 01.08.2013 01.09.2013 01.10.2013 02.10.2013 01.11.2013 01.12.2013 01.01.2014	Bottom H 63,084543 68,786751 73,779056 78,108902 82,254371 85,719287 88,767025	Hole Pressure	Bottom 0 0 0 0 0 65,39 0 0 0 0	Hole Pressure (samples)			BHP 1 2 3 4 5	well3: *Obj 3 3 3 3	txt 🔀 ect 08.3 02.0 02.1 02.0	Data 10.2011 03.2012 10.2012 03.2013	BHP mea 45.19 51.5 40.48 42.15	asure
	01.02.2014 01.03.2014 02.03.2014 01.04.2014	91,375723 93,140191 94,841377		0 0 77,93 0			₹	6 7 8	3 3 3	02.0	10.2013 03.2014 10.2014	65.39 77.93 82.93	
	01.05.2014 01.06.2014 01.07.2014 01.08.2014 01.09.2014 01.10.2014	96,150832 97,36776 98,063701 98,874762 99,734802 100.621064		0 0 0 0 0 0									
	02.10.2014 01.11.2014 01.12.2014 01.01.2015 01.02.2015	101,666019 102,506481 103,414031 104,221833		82,93 0 0 0 0		~							







The rule Temperature of Injected Fluid

(Strategies \rightarrow Thermal Properties \rightarrow Temperature of Injected Fluid)

B	🔓 🎢 🕛 💵 🗙 🗆 Run till Step: 0 🌲 🛛	÷ N	0000 - 15.05.2011 0	:00 ~ 🕑 🗸	
-	Cases		Tables 🗙 📋 🗄	Strategies 🗙	🖹 Sch 🜗 🕨
344	Geometry Objects	Temp	perature of Injected	Fluid	
ドン	Fluid Properties		Well	Injected Fluid C	Temperature,
Ĩ	Wells Data	1	1	20	
	Calificative Darles	2	15	20	
	Schedule Rules	3	24	30	
		4	26	30	
	> Global Rules		Type or paste		
	✓ ■ 15.05.2011				
	ಥೆ, Create Group Hierarchy				- 1
	Result Files Control				- 1
	A Well Specification Parameters (1)				
	A Well Production Limita (Historical) (1)				I
	A Temperature of Injected Fluid				I
	> (J) 18.06.2011				
	Corresponds to	the	e wiemp ke	eyword	I
	> 0 01.07.2011				



A rule to set the temperature of injected fluid is now supported (corresponds to the WTEMP keyword)

🔅 Settings 🛛 🗙 🗙		IL G	raphs 🗙		🗊 Block		
Q		22					
V Wells							
> 1 11							
> 🛉 '3'					-		
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> 1 · · · · · · · · · · · · · · · · · ·		U					
20 20 27'	\mathbf{v}	e e			-		
ΣΞΧ		02 erati		• • •			
					-		
Template Name: Template 1		μ≞					
← 🖌		10					
Q		19					
Productivity Index							
Temperature of Injected Fluid					-		
Tubing Head Temperature		18					
VFP table number			-				
VFP table number (H)			20)12	2013	2014	201
Water Productivity Index	\mathbf{x}				Date		
< >			📌 1:Ten	nperatu	ire of Injec	ted Fluid	









Fracture Simulator



Contents

- It is now possible to take into account the mutual influence of fractures implemented at different wells to model the fracture stage at the current well
- Automatic use of calculated properties in the simulation model for the calculation of fracturing stages is now supported







Stress Shadowing between Wells

the injection

Tracture Sim	nulator Settings						×
Current Object Settings_Well_3							
Grid Data	Nell Slurry	Run Options					
Grid Properties	5					_	
a:10 0 4	-	Length		4.5	2	2	
Grid Step, ft: 4.	5			4.5			
Time Step Sett	ings						
lotal Report Ste	eps: 49						
Min Step, secor	nds: 0.001						
Newton Prope	rties						
Max Iterations:	30						÷
Tolerance:	0.01						
Var. tolerance:	0.01						
-Linear Solver P	roperties						
Max Iterations:	500						÷
Tolerance:	0.0001						
Tuning							
Shear Dampeni	ng Radius, ft:	20					
Crack Criteria T	olerance:	0.2					
Stress Shadowi	ng Mult:	3					
			FS Results				
Cross-Stage Str	ess Shadowing	Type or paste	here				
					OK	Cancel	Apply



It is now possible to take into account the mutual influence of fractures implemented at different wells

to model the fracture stage at the current well. To do this, in Fracture Simulator Settings the user

should specify the calculated fracturing stages that will be taken into account, as well as the start of









Use Calculated Props from the Dynamic Model

Automatic use of calculated properties in the simulation model for the calculation of fracturing stages

calculated for the reporting date which is closest to the stage creation date

Contents of the second	odel with anical			Wuh2		
Definition	Static Aquifers	Fluids Fault	Writing of Results	Restart	Schedule 🕘 🕨	
Properties	Graphs Addition	nal Properties	Additional Graphs			
 E1/E3 Binary Export Request Output of Initial Properties 						
Mnemonic	Value De	cription			^	
✓ STRDLT Initial Stress □ PRSGRD Pressure gradient						
☑ DISPLMNT Displacement vector ☑ HMAXSTR Effective Max Stress (Horizontal) ☑ MAXSTR Effective Max Stress ☑ MINSTR Effective Min Stress						
		CUAC MILL SUCSS			 `	



is now supported. Grid properties for the stage will be automatically set from the dynamic model

IN Fracture Simulator Settings	
Current Object Settings1	
Grid Data Well Slurry Run Options	
Grid 🛱 Results (TEST444_STRESSINIT: result)	
Rock Properties Stress Properties Reservoir Conditions	
Fracture Angle, deg	
Constant 90	
O Use Principal Stress Vector	
- Minimal Principal Stress, bars	
O Constant 140	
Property MIN_STRESS_VAL_RESGEO	
Minimal Principal Stress Direction	
X Y	Z
O Constant 1 0 0	
● Property MIN_STRESS_X_RESGEO ▼ MIN_STRESS_Y_RESGEO ▼ MIN_STRESS_Y_RESGEO	Z_RESGEO

When the grid of a calculated dynamic model is chosen, all fields in the settings will be filled with the corresponding properties if they are calculated









Import Fault data from an external file



It is now possible to import fault data from a model or an external file. In this case, the fault data must

be specified using the FAULTS keyword (3D-Grids \rightarrow Faults on Grid \rightarrow Import Fault Grid from a Model)





102

Automatic graph template loading

It is now possible to load graph templates automatically for new projects. It allows use of pre-prepared graph templates to analyze field development parameters (Settings \rightarrow Options \rightarrow General \rightarrow Use Graph Templates for New Project/Models)

IN Options	×
General Models Paths Graphics Captions Updates Client Options Designer Advanced	Settings Apply Settings File for Models Opened First Time Settings File: C:/Users/nikolay.fisun/tNavigator/default.tNav Use Graph Templates for New Projects/Models Graph Template File: C:/WORK/BlackOilDEMO/user_template.grt Number of Recent Documents: 10 Action for Unavailable Documents: Ask for Action Controls: Default Gas and Oil Model Gas Model Differentiate Loaded Graphs: Using Color Shift
	OK Cancel Apply Help









RP Designer



Contents

- The SRP tab has been added (scaled relative permeabilities)
- The hysteresis effect can now be calculated
- RP curves can now be visually edited by changing endpoints
- Multiple graphs' colors can be edited at once



RP Designer: SRP tab (scaled relative permeabilities)

- The SRP tab provides the following possibilities:
 - to visualize RP curves while changing endpoints;
 - to calculate the effect of hysteresis;
 - to calculate RP curves in the presence of surfactants

Variants	Data Graphs SRP +	
Variant 1 (Corey) Variant 2 (LET)	 ✓ ✓ Drainage ✓ RP Water Drainage ✓ RP Oil (Water/Oil) Drainage ✓ Cap. pressure/J-func (Water/Oil) 	1.0 RP Water (Drainage) RP OIL (Drainage) Capillary Pressure (0.8 0.6 0.6
	Paint graphs in one color Hysteresis Imbibition Variant:	
	Variant 1 (Corey) ~ Surfactant Surfactant Variant:	0.2
	Variant 1 (Corey) ~ System: Water-oil system ~	0.0 0.2 0.4
Capillary Pressures		Satu



Model Designer 21.4











RP Designer: change RP endpoints

It is now possible to visualize RP curves while changing endpoints (Variants \rightarrow SRP \rightarrow Settings \rightarrow

Scaling/Hysteresis/Surfactant)









RP Designer: the Hysteresis option

the main curve (drainage), the imbibition curve (Variants \rightarrow SRP \rightarrow Hysteresis)



The new SRP tab allows the calculation of the hysteresis effect. It is now possible to select a variant for





RP Designer: the Surfactant option



The new SRP tab allows the calculation of RP curves in the presence of surfactants. It is now possible

to select a variant for the RP curve in the presence of surfactants (Variants \rightarrow SRP \rightarrow Surfactant)




Data input/output

New grid properties are available Cases \rightarrow Properties \rightarrow Writing of Results \rightarrow **Additional Properties**:

- Mass densities of water, oil, and gas in a black o (MASSDENO/W/G)
- Oil-in-place mass (OIPM), mobile oil-in-place (MOIP), mobile oil-in-place mass (MOIPM)
- Molar densities of components (MLSC, MWAT)
- K-values (KVALUES)
- Number of convergence problems in each block (CPN)
- … etc.



Simulator, Model Designer 21.4

	🌣 Properties 🗙	< zdol 🥎	: +				
	Definition Stati	c Aquifer	Fluids	Faults	Writing of Results	Restart	Schedul
	Properties Gra	phs Addit	ional Propert	ties Ad	ditional Graphs		
	E1/E3 Binary Exp	ort					
	Request Output	of Initial Prop	erties				
	Q						
	Mnemonic	Value [escription				
	EOSNUN	И Е	quation of st	tate region	numbers		
	CPN	N	lumber of Co	onvergence	e Problems		
	WIP	٧	Vater in Place	2			
			il in Place				
oil model		C	il in Place (N	/lass)			
	MOIP	N	Iobile Oil in	Place			
		N	lobile Oil in	Place (Mas	s)	J	
	FOIP	F	ree Oil in Pla	ce			







PVT Designer





PVT Designer 21.4



PVT: extrapolating a saturated branch

When creating a black oil variant based on a compositional one, a saturated branch can be

Rock Flow Dynamics

	+	🗽 Experiment Options 🗡	
	Experiments •	Tab Name: PVT 2	Belore
ſ	DV/T	Hydrocarbons Viscosity vs Temperature	
	Phase Envelope K-values Quality Control	Pressure, barsa From Range Number of Values/Stages: 20 Minimum: 10.1325 Maximum: 200 From Sample Samples: CCE Sample 1 Saturation Properties at P > Psat Saturation Properties at P > Psat Sc Pressure, bars: 1.01325 Sc Temperature, C: 15 Sc Temperature, C: 15 Sc Temperature, C: Sc Temperature, C: Sc Pressure, bars: Sc Pressure, C: Sc Pressure,	
neco e ga	essary, the composition as/condensate being	 ○ No ○ Add gas/cond ○ Add gas/cond + extrapolation ○ I Use Gas Table ○ No Separators: ○ From Sample ○ Separators: ○ From Sample ○ Separator 1 ~ 	After
ldec	can be specified	Fraction, kg-mol/kg-mol Extrapolates up to the maximu possible P _{sat} in the set range C1 0 C2 0	
		C3 0 Normalize Fractions Extrapolates up to the specified Hydrocarbon Temperature, C: 100	sat
Nai	vigator ®	Allow Different Options for Different Variants OK Cancel Help	

extrapolated above the specified saturation pressure in the case of gas injection into the reservoir



Compositional: multiple water components

Multiple water components and their properties can now be set in compositional variants

Components	•	Saturatio	n Pressure 1 ×	Phase Er	nvelope 1 ×	• CCE 1 ×	
Component Pro	perties	Binary	Interaction Coe	efficient 💧 Wa	ter Split Tabl	es	
🔵 Default 🖲 C	ustom	J					
							_
N Water Settings						Water Set	tinad
○ Water (○ Salt	Water	NaCl	 Ø Multi Com 	ponent Water			unga
Pressure, barsa							
Number of Values/S	Stages:	20					
Minimum:		10.1325					
Maximum:		250					
				ater Properties at R	eference Temperat	ore.	
Water Compon	Com fra	position, action	Molecular Wei kg/kg-m	Reference Press bars	Compressibility, 1/bars	Reference Mass kg/m3	Referer
WATER1	0.2		17	200	3.94769e-05	991	0.31
WATER2	0.2		17	200	3.94769e-05	991	0.31
WATER3	0.3		19	200	3.94769e-05	999	0.36
WATER4	0.3		18	200	3.94769e-05	995	0.34
Type or paste							
The colu	imne	s corr	espond to	the follow	vina kovv	orde:	
VVINA	VIES	, vvi ,	IVI VV VV/IVI VV	VVJ, PKEF	W/PREFW	·3,	
·	CRE	FW/C	CREFWS, D	DREFW/DR			









Workflow: matching to samples

Compositional and black oil variants can now be matched to samples





	Use for Matching: C	Component Property					
	Variant Name: Lui	mping Variant 1 1					~
	Composition: Co	mposition 3					~
	Clean Prepared	for Matching					
g: Component Property	Component Na	Property Type	Use for Matching	Min	Base Value	Max	Keep Order
g: EOS Property	C16+	Critical Temperature		745	823.685	988.422	
es	C8-C15	Critical Temperature	\checkmark	548	659.301	739	
	C16+	Critical Pressure					

★ / I I I A J	Use for Matching: E	OS Property					
	Variant Name: Lui	mping Variant 1 1					~
	Composition: Co	mposition 3					~
	Clean Prepared	for Matching					
: Component Property	Property Type	Component Na	Use for Matching	Min	Base Value	Max	Keep Order
: EOS Property	Shift	C16+	2	0	0	12	
25	Shift	C8-C15		0	0	1.2	

	Variant Name: Lu	Imping Variant 1 1			~
	Result Variant Nam	ne Matched			
	-Main Options				
Component Property	Algorithm Pa	article Swarm Optir	mization		~
EOS Property	Max Iterations 10	000			÷
	Stop on Slow	Improvement			
	Number of Iterati	ons 1000			-
	Improvement Val	ue (%) 2			
	Experiments for M	atching			
	Composition	Experiments	Samples	Weigh	Jht
	Composition 3	CCE 1	CCE Sample 1	1	
	Composition 3	DLE 1	DLE Sample 1	1	
	Composition 3	Grading Test 1	Grading Test	1	



Network Designer





Network Designer 21.4



Export objects in a custom format

menu Edit → Export → Import/Export Objects in Custom Format)



It is now possible to export data for network objects in tabular form in a user-specified format (the top

Import objects in a custom format

It is now possible to import data for network objects in tabular form in a user-specified format (the top menu Edit \rightarrow Import \rightarrow Import Objects in Custom Format)

Projec	t Settings Files	Edit	Project Management	Help						
	Contractions for the second se	 <	Open Python Actions Ed Open History Editor Open Events Editor Open Time Steps Editor	litor	Sch	eme	O € Map ×	15.	12.2021 ~	jects >
	 2-phase Sep 3-phase Sep Automatic C Automatic P Automatic P Chokes Compressor Constraints Constraints Groups of El Injectors Injectors Injectors Joints Master Cons Pipes Pumps Python Obje Sinks Sources Well Gas Lift 	umps s ements traints ects	mport Export	plates pla	Imp Imp File Pro Stru File	oort O Impor e Nam stand stand stand stand stand stand istand atand not eview icture Previe Imiter Previe	bjects in C t Project in C lalone_netwo lalone_netwo lalone_netwo lalone_netwo lalone_netwo lalone_netwo rows X Re Preview: Ne ew: standalo	uston Custor ork_sir ork_to ork_to ork_to ork_to ork_we emove etwork	n Format	Im Sir So or.txt Th Ne W
	Wells		Show Object La	bels 🌩		St 1 2 3 4	tructure Type Structure Ty topology topology topology	• ~ /pe /	Object From Object From Well B1 Well B2 Well B3	Object Object Cho Cho
		Ur								







View the parameters of imported objects

topology imported from a file in tabular form.





In the Tables tab, it is now possible to see the parameters of the network objects and the network

021 v Vell Efficiency Factor Object Mode Reservoir Coupling Model VFP Rate Type 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalone • Not set • well project: VFP1 Mass Fracti 1 Standalon										
Objects × Branches × Pipes × Graphs × + ncy Well Efficiency Factor Object Mode Reservoir Coupling Model VFP Rate Type 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • Not set • well project: VFP 1 Mass Fraction 1 Standalone • </th <th>021</th> <th>~</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>	021	~								
ncyWell Efficiency FactorObject ModeReservoir Coupling ModelVFPRate Type1StandaloneNot setwell project: VFP1Mass Fraction1StandaloneNot setwell project: VFP1Mass Fraction		Objects ×	Branches	×	Pipes >	<	Graphs ×	+		
1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction 1 Standalone Not set well project: VFP 1 Mass Fraction	ncy	Well Efficie	ency Factor	Obje	ect Mode		Reservoir Co	upling Model	VFP	Rate Type
1StandaloneNot setwell project: VFP 1Mass Fraction1StandaloneNot setwell project: VFP 1Mass Fraction		1		Stan	dalone	-	Not set	.	well project: VFP 1	Mass Fractions
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1 Standalone 🔻 Not set 👻 well project: VEP 1 Mass Fracti		1		Stan	dalone	-	Not set	.	well project: VFP 1	Mass Fractions
wen project vit i Massifiacu		1		Stan	dalone	•	Not set	-	well project: VFP 1	Mass Fractions







Well control by Network Designer

For integrated models, Network Designer has top priority in terms of controlling a well

Settings \rightarrow Parameters \rightarrow Properties \rightarrow Control Integrated Wells By Network Designer



N Solver Parame	ters				×
Solver Settings	Properties	Pipe Solve	er Settings		^
Singlephase correl	ation:			Moody	
Elevations in graph	is:			From Map	
🗌 Identify Pipe Se	gments With H	lydrates			
Calculate erosion Data for erosion	on calculation —			2	
Erosion velocity	constant, (kg/n	n/s^2)^1/2:	122	9	
S - geometry fac	tor:		1		
Sand production	, kg/day:		0		
Use deWaard (1	1995) corrosion				
Corrosion efficien	ncy: 1				
Mole fraction of (CO2 (only for B	lackOil): 0			
Use actual pH					
Specify:					
-Bottleneck Proxim	mity				_
Enable Testing					
Set Custom P	arameters				
Rate Change Ra	itio: 0,1				
Control Integra	ted Wells By No	etwork Desig	jner		













Well control by Network Designer

Network Designer has top priority in terms of controlling a well

Activation of a well is equivalent to specification of the WCONPROD keyword along with THP control

Project Settings Files Edit P anager	Networ Designe	k er	,	5 韋 25.05.2	2011 ~	
Parameters	<u>^</u>	Sci	neme	Objects ×	Branche	s × Pi
 2-phase arators 3-phase arators 						
Solver Parameters	,					
Solver Settings Properties Pipe Solver Settings	Moody	^ (<u>^</u>	/1 0	Pipe 1	- 😮
Elevations in graphs:	From Map		9		-	$\mathbf{\overline{\mathbf{v}}}$
Identify Pipe Segments With Hydrates	Tommup					
Calculate erosion						
Data for erosion calculation						
Erosion velocity constant, (kg/m/s^2)^1/2: 122		1	W1			
S - geometry factor: 1						3
Sand production, kg/day: 0			✓ Well	ļ		
Use deWaard (1995) corrosion			1	Vame		W1
Corrosion efficiency: 1			S	Status		Active
Mole fraction of CO2 (only for BlackOil): 0			E	SP Frequency, I	Hz	
Use actual pH			V	Well Efficiency F	actor	1
Specify:			(Object Mode		Simulator
Bottleneck Proximity			F	Reservoir Coupli	ng Model	
Enable Testing			N	/FP	-	
Set Custom Parameters						
Rate Change Ratio: 0,1						
Control Integrated Wells By Network Designer		~				



Well control is specified by Simulator



Temperature profile in a well

calculations (Settings \rightarrow Parameters \rightarrow Solver Settings \rightarrow Use Temperature Equations)





For Standalone and integrated models, the temperature profile in a well is taken into account in

Import PS project

- The top menu Project \rightarrow Import \rightarrow Import PS Project



The network topology will be imported to the Scheme tab along with the object parameters coinciding

with the parameters in Network Designer, and the fluid model used in the PS project will be detected



Separator

It is now possible to specify phases' fractions directed into the separation object(s)

(RMB on the object \rightarrow Edit \rightarrow Data Type \rightarrow Advanced

<u> </u>	<u>P</u> roject	<u>S</u> etti	ings <u>F</u> iles	<u>E</u> dit	Project I	Manageme	ent	Help			
ł		3 4	ı 🌆 E	abc	3. (5	<u>tn</u>	3-phase Separator			
			2-phase Sep 3-phase Sep 3-phase Sep Automatic Automatic Chokes Compresso Constraints Groups of E Injectors Joints Master Con Pipes Pumps Pumps Pumps Python Obj Sinks Sources Well Gas Lif	anators barators barators Chokes Pumps rs lements straints ects	Solution of the second			3-phase Separator 3-phase Separator Name Status Data Type ✓ Gas Separation O Water Fractio Oil Fraction Gas Fraction Water Separation Oil Fraction Gas Fraction Oil Fraction Gas Fraction Oil Fraction Gas Fraction	bject n Object n	3-phase Separa Active Advanced Comp_line 0,2 0,2 0,9 Pump_line 1 0,05 0,01	3to
		> (1)	Wells		⊡ Sh Visua Ident	iow Objec iow Disab lization Se fy Pipes					





Bottleneck analysis

panel (Settings \rightarrow Parameters \rightarrow P

Solver Paramet	ters			×
Solver Settings	Properties	Pipe Solver Settings		^
Singlephase correla	tion:		Moody	
Elevations in graph	S:		From Map	
ldentify Pipe Se	gments With H	lydrates		
Calculate erosio	'n			
Data for erosion	calculation —			_
Erosion velocity of	onstant, (kg/m	n/s^2)^1/2: 122		
S - geometry fact	or:	1		
Sand production,	kg/day:	0		
Use deWaard (1	995) corrosion			
Corrosion efficien	cv: 1			
Mole fraction of C	02 (only for Bl	ackOil): 0		
Use actual pH				-
Specify:				-
				-
Bottleneck Proxin	nity			
✓ Enable lesting				
Set Custom Pa	arameters			_
Rate Change Rat	tio: 0,1			v



Project Settings Files Edit Project Image: Settings Files Image: Settings Image: Settings Image: Settings Image: Settings Image: Settings Image: Settings Image: Settings <t< th=""><th>rop</th><th>perties \rightarrow En</th><th>a</th></t<>	rop	perties \rightarrow En	a
Image: Section of the se	<u>P</u> rojec	ct <u>S</u> ettings <u>F</u> iles <u>E</u> dit Proje	ect N
Constraints Constraints </th <th>B</th> <th>🗔 💺 🌆 🕞 🔤 💑</th> <th>6</th>	B	🗔 💺 🌆 🕞 🔤 💑	6
l l doot		Q Image: Q	xtho bjec Sh Sh Sh Sh Sh
	19:0	o.ooj ripe o: bottle-netk	hu
[5.50100] Tipe 6. bottee neek pre			
[5130100] Tipe of bottle fick pro	<		
<	Log	Initial Warnings All Warnings	2

It is now possible to analyze a pipe capacity compared to its current state. If the rate through a pipe at the current conditions is close to its capacity limit, a warning appears in the project log in the Log



▲ Warnings 🝸 🚺 91 🔼 1



















Pipe visualization variants in the Scheme tab

icon with the VFP symbol, which indicates that a VFP project is in place for the pipe



The possible options include a standard icon, an icon visualizing hydrates formation in a pipe and an

Coupling several Standalone models

field specify the name of an object in the coupled project of the surface network)



Each network should be active and have the same data steps. The coupling is carried out via Sources

and Sinks (RMB on the object \rightarrow Edit \rightarrow Data Type \rightarrow Dependent Object and in the Dependent Object

	_	
	Dense dest Object	
	Dependent Object	
	gası A əti və	
	Active	Droject GAS: Source 1
cı		Project-GAS: Source I
	Dependent Object	
	qas2	
	Active	
ct		Project-GAS: Source 2
	1	
	_	
	Dependent Object	
	wat1	
	Active	
ct		Project-WAT: Source 1









Rotation of network objects in the Scheme tab

The button in the right panel \rightarrow Alignment of Selected Objects \rightarrow Rotate 90 Degrees Clock-wise and

Rotate 90 Degrees Counterclock-wise







G-

<u>tn</u> ti	Navigator			
	Object Name	X, m	Y, m	
1	Choke 1	13531668,375746	7145834,287969	-2,76
2	Choke 2	13531432,730048	7145847,685201	-1,63
3	Choke 3	13531437,114232	7145433,363893	1,474
4	Choke 4	13531718,998075	7145492,697962	0,122
5	Joint 1	13531634,18803	7145741,755049	-1,11
6	Joint 2	13531467,920786	7145754,149258	-0,52
7	Joint 3	13531494,743564	7145600,634159	0,952
8	Joint 4	13531691,516054	7145598,298492	-0,07
9	Choke 5	13532519,80024	7148928,457599	-14,2
10	Choke 6	13532380,642789	7148943,313904	-12,3
11	Choke 7	13532362,298868	7148805,848052	-12,6
12	Choke 8	13532471,279041	7148751,586383	-14,2
13	Joint 5	13532503,701341	7148892,203098	-14,1
14	Joint 6	13532405,304099	7148911,565111	-12,8
15	Joint 7	13532392,92515	7148825,6669	-12,9
16	Joint 8	13532489,526374	7148814,178129	-14,2

Synchronize Z Coordinates With **Horizon Only Visible Objects**





Well Designer





Well Designer 21.4



Sucker Rod Pump





Well Designer 21.4

Parameters of Sucker Rod Pump







Multiediting





In the Well Construction tab, it is possible to multiedit parameter values of well construction elements The depth may now be visualized both in measured depth (MD) and in true vertical depth (TVD)

			1		
tion, m		Name	Depth (MD), m	Strength of AICD, bars/((kg	/m3)(rm3/day)2)
2000	1	AICD 1	3732	2,3e-07	
	2	AICD 2	3237	2,3e-07	
	3	AICD 3	2820	2,3e-07	
	4	AICD 4	2560	2,3e-07	
		Type or			
AICD 4					
MD: 2560.00, m					
<u>^^^^^^</u>					
(202) (203) (203)					
<u>N</u> <u>N</u>					
~~~~~~		Different	Different	2,3e-07	
	<				>

















## Well construction errors

## The well project log in the Log panel can now be used to control errors occurring when creating a well

### construction



T	E	(i) 2	0 0	0
---	---	-------	-----	---









## **IPR curves**

## It is now possible to visualize several selected IPR curves in the IPR tab

Temp IPR B	erature Profile ase: Liquid	Well Profile • VFP 1 ×	•	VFP 2 × • VF
PR N	1odel: Well Test	Data 🗸		250
IPR	Model Data			
	BHP, bars	Volume Rate, sm3/day		
1	250	0		200
2	235	31,2		200
3	195	70,7		
4	100	121,17		
5	50	133,9		150
6	1,0135	140,4	S S	
	Type or paste		p ^g	
			H	
				100
how	Other IPR			
Q				50
5	IPR 2			







## Heat losses along a wellbore

parameter of the WELLDATA keyword) are taken into account

	Project View Settings Files Reports Project Manager Help
🔚 model_sch_with_temp.inc 🔀	
Imodel_sch_with_temp.inc       Image: sch_with_temp.inc         4       5       WCONPROD         6       wname status control orate wrate grate lrate lrate (rc) BEP TEP         7       'WELL' OPEN THP 2* 1* 3* 10 /         8       /         9       0         10       WELLDATA         11       name branch mdu mdl md/tvd parameter value         12       'WELL' 0       200 400 MD TEMPERATURE 12 /         13       'WELL' 0       400 1000 MD TEMPERATURE 40 /         14       'WELL' 0       1000 1500 MD TEMPERATURE 60 /         15       'WELL' 0       1500 2000 MD TEMPERATURE 80 /         16	→ →   Definitions   Definitions   Grid Properties   Graphs   Graphs   Auto Sync   Q   ✓   Wells   >   Totals   Fluid-in-place   Analytics   Pressure   Flow Between FIPs   Run Statistics   Crossplots   Well Profile   Well Section   User Arithmetics   Plack lafe
20 'WELL' 0 1500 2000 MD CONDTUBE 22 / 21 / 22 23 DATES 24 01 FEB 2018 / 25 /	Block Info   Profile Info   Caraph Templates   Waterflood   2D Histogram     Block Info   Orawdown   Waterflood   WBP0   WBP4

Fluid Properties

Schedule

😰 M



# The environment temperature (the TEMPERATURE parameter of the WELLDATA keyword) and the coefficient for the heat exchange between the wellbore and the environment (the CONDTUBE







# **VFPPROD** points for Black Oil

**tNavigator**®

## **Points** table, which are used in calculation of VFP curves based on the compositional model



## It is now possible to edit the points of parameters of a black oil model in the VFP Correlation Plotting

perature Profile Well Prof	ile 💽 🛚	/FP 1 ×	•	VFP 2 ×	+					
	T k	HP, ( pars (	(FLO : 1	BHP IM = 100 kg bars	(FLO : b	3HP TM = 10 pars				
	5	1	2,739		24,1662					
	14,5	3	31,0282		41,4016					
	24	5	51,4202		57,1852					
	tn vfp	Correlatio	n Plotti	ng Points						
		THP, bars		FI	LO	WOR	WFR	GOR	GFR	
	5			50	, sins/ day		-		· , 3113/3113	
	14,5			100		02		1		U Turne or parts
	33.5			200		0,2		5		Type or paste
60 80 1	00 43			300		0.6		10		
e 00 1	52,5			400		0,8		50		
<b>.</b>	62			500		Type or p	aste here	100		
	71,5			600				200		
	81			700				300		
	90,5			800				400		
	100			900				Type or pa	aste here	
	Туре о	r paste here	e	1000						
				Type or paste	e here					
ith Fixed: FLO : TM	_ <b>+ &gt;</b>	K 🖉		+ × 🖉		+ ×	Ø	<b>+ ×</b>	<i>•</i>	+ × /
0										OK
46,1414	Botto	m hole da	tum de	epth <mark>(</mark> TVD),	m: 1982,352	94118				
0	VFP N	umber:			1					





# Modeling the corrosion of well material

### The corrosion of well material may now be modeled using the deWaard (1995) model with the help of the WELCORER keyword 3D Histogram











### **Corrosion of tubing**



roje	ct View Settings File	25
•	- 🗖 💾 🐰 🥕	Ŧ
	Definitions	
Ċ.	Grid Properties	
	Graphs	
	Rates	~
	Totals	
	Fluid-in-place	
	Analytics	
	Pressure	
	Flow Between FIPs	۷
	< >	
	Graph Templates	
	Waterflood	
	2D Histogram	
	Fluid Properties	

### R_V_1_2_welcorer.DATA

WELCORER

PROD_1_vfp_project_corr / CORROSION EFFICIENCY 0.57 / MOLE_FRACTION_CO2 0.08 / ACTUAL_PH 5.5 /

















## Well Profile tab

combinations of rates, tubing head pressures (THP), GFR, WFR, ALQ and correlation types

Basic Data Geometry 3D	Well Construction Well	Test Data Schedule	Temperature Profile	Well Profile	• VFP 1 ×	• VFP 2 ×	•	VFP 3 ×	• Table_1 ×	• VF	P4× IPR1×
Initial Parameters			Well Profile Graph	s			Grap	h Table		- I	
		N - 10		Pres 100	ssure, bars	200		MD, m	Variant 1: Press bars	MD, m	Variant 2: Press bars
variant ivame		variant 2					1	0	50	0	50
Result	Success	Success	0				2	8	50.7752	8	50.76
THP, bars	50	50	-∥ ₹.				3	16	51 5504	16	51 5199
FLO	100	100	200					22	52 101	22	52.04
FLO Type	OIL, sm3/day	OIL, sm3/day	, 200					52	55,101	52	55,04
WFR	0,8	0,8		$\mathbf{X}$				120	50,2022	120	50,0802
WFR Type	WCT -	WCT .	400	•			0	128	02,4038	128	02,1017
GFR	0	0		N N			/	256	/4,81/1	256	74,3283
GFR Type	GOR, sm3/sm3	GOR, sm3/sm3	600				8	384	87,2337	384	86,4998
ALQ	0	0					9	512	99,6556	512	98,6764
ALQ Type	GRAT, sm3/day	GRAT, sm3/day					10	640	112,083	640	110,858
Fluid	Variant 1	Variant 1					11	768	124,516	768	123,044
Vertical Deviation Swap Angle	30	30	<u> </u>		<b>N</b>		12	896	136,954	896	135,236
Horizontal Deviation Swap Angle	60	60	≥ 1000		~~~ <b>\</b>		13	1024	149,397	1024	147,432
Vertical Part Of Well	Hagedorn-Brown corr.	Fancher-Brown corr.					14	1152	161,846	1152	159,633
Deviated Part Of Well	Beggs-Brill corr.	Beggs-Brill Revised corr	1200				15	1280	174,301	1280	171,84
Horizontal Part Of Well	Beggs-Brill corr.	Beggs-Brill corr.	•		le la		16	1408	186,76	1408	184,051
Friction	1	0,1	1400				17	1536	199,225	1536	196,267
Hydrostatic	1	1	1400				18	1550	200,589	1550	197,603
<		3					19	1550	200,596	1550	197,61
+ Create X Remove			1600				20	1558	201,36	1558	198,373
Granhs							21	1566	202,124	1566	199,135
		,	1800			····· • • • • • • • • • • • • • • • • •	22	1582	203,653	1582	200,659
Pressure						•	23	1614	206,709	1614	203,708
Interfacial Tension Oil Volume Rate SC			Variant 1: I	Pressure	•• Variant 2: I	Pressure	24	1678	212,824	1678	209,806



# It is now possible to show several parameters (pressure, temperature, etc.) simultaneously for different





# **Licensing and License Server**





### License server 21.4





## **Licensing and License Server**

License use statistics aggregated by users, groups, queues, and license types may be visualized in the tNavigator graphical interface.

	License Server Report localhost:8057[group:1]						
Group	GUI	black oil	compositional	geology designer	history matching	model designer	network designer
1	258	0	0	168	0	168	168
1	27418	1	0	38286	1229	38286	0
1	5440	4183	4130	10	0	234	10
1	542	71	0	92	0	387	0
1	456	0	0	0	0	455	455
1	2855	0	0	2855	0	0	0
1	8333	420	0	7986	0	8350	7986
1	10019	768	5	5617	10	6761	1903
1	4569	16	14	1351	0	1351	0
1	83	77	0	0	0	0	0
1	1553	0	0	1459	0	1459	0
1	3038	4758	0	263	1875	263	0
1	32342	2905	2526	0	0	0	0
1	15164	0	0	13589	0	543	0
Total: GUI 112070	min, black oil 1319	9 min, compositior	nal 6675 min, geolo	gy designer 71676	min, history match	ing 3114 min, mod	el designer 58257 min, network designer 10522 min
							Save Selected to File X Close

### A summary table on the use of licenses has been added to the calculation log.

THERM11_	FIX.log 🔀
23113	Licenses info
23114	+======================================
23115	Maximal number of Black Oil licenses
23116	Total Black Oil licenses utilization t
23117	Maximal number of Compositional licens
23118	Total Compositional licenses utilizati
23119	Maximal number of Thermal licenses
23120	Total Thermal licenses utilization tim
23121	+======================================
00100	

**t**Navigator[®]









# **Documentation & Localization**





### **Documentation 21.4**



## **Built-in documentation**

## A section with the list of supported keywords in IN format is available as a part of User Manual.

17. Keywords for format IN 3252

## **17. Keywords for format IN**

The keywords of format IN correspond to certain keywords of tN/E1/E3 formats according to the following tables. Note that the keywords related to initial data arrays are listed separately in the second table.

**IN keyword** 

BINARYINTERACTIONCOEF

BOXPROPERTYEDIT

BRINECOMPONENTCOMPRESSIBILITIES

BRINECOMPONENTPROPERTIES

BRINECONCENTRATIONDEPTHTABLE

BRINEFLUIDMODEL

CAPPRESSURE

CAPPRESSUREHYSTERESIS

CARLSONRELPERMHYSTERESIS

CARTERTRACY

CARTERTRACYINFLUENCEFUNCTIONTABLE

CELLACTIVITY

CELLDOUBLEPROPERTY



### **IN** keywords

Corresponding tN/E1/E3 keyword(s)					
BIC (see 13.16.46)					
ARITHMETIC (see 13.3.2)					
BDENSITY (see 13.7.7), BRINE (see 13.1.61), PVTW (see 13.5.9), PVTWSALT (see 13.7.8)					
BRINE (see 13.1.61), ECLMC (see 13.1.63), SALTVD (see 13.18.54)					
BRINE (see 13.1.61), SALTVD (see 13.18.54)					
BRINE (see 13.1.61), SALTVD (see 13.18.54)					
SGFN (see 13.6.14), SWFN (see 13.6.13)					
EHYSTR (see 13.6.92)					
EHYSTR (see 13.6.92), SATOPTS (see 13.1.76)					
AQUANCON (see 13.19.11), AQUCT (see 13.19.9), AQUDIMS (see 13.19.1)					
AQUDIMS (see 13.19.1), AQUTAB (see 13.19.10)					
MINPV (see 13.2.31), PINCH (see 13.2.63)					
SOLUTION (see 13.18.1)					



**Unavigator**[®] 21.4

# New training tutorials (1)

- A tutorial for Geology Designer:
- **GD4.7. How To Work With SEGY Headers**
- This tutorial provides a workflow for import of seismic 3D data in the case where
- the text header contains no information concerning the inlines and crosslines positions in the SEG-Y file.
- A tutorial for Geology Designer and Model Designer: **COMMON1.9.** How To Create Dual Porosity Models via DFN This tutorial covers the basic workflow for creating discrete fracture network (DFN) and dual porosity (DP) models in Geology Designer and Model Designe The input data are loaded, the geological and (later) dynamic models are built, then the calculations are run and the results are analyzed. **TNavigator**®







# **New training tutorials (2)**

**A tutorial for Model Designer:** 

MD3.3. How To Create Geothermal Model

This tutorial explores the creation of a geothermal black oil model with temperature extension using a simple grid with a five-point well placement system as an example. The tutorial also includes the .data file of the resulting geothermal model.

- **A tutorial for Model Designer and AHM:**
- MDAHM1.5. How To Use Ensemble Smoother Method

In this tutorial, we show the approach to running the ensemble smoothing method.

The initial data are loaded into Model Designer, the necessary variables and

workflow are created, an initial ensemble of variants is generated, and the ensemble

smoothing method with the defined objective function is started.







# **New training tutorials (3)**

A tutorial for Simulator:

SIM6.10. How To Model Single Well Chemical Tracer Test This tutorial explores a compositional model with chemical reactions. The ester is modeled as two components, one in the oil phase and the other in the water phase. The distribution of ether between phases is modeled using chemical reactions. The ester dissolved in water reacts with water to form ethanol and acetic acid.









# Thank you for your attention!

## The complete list of new features is available in the Release Notes

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tNavigator[®] 21.4

### igator 21.4

features in tNavigator 21.4 are:

oftware (an installer) for the Linux version of tNavigator has been added. The runs on the console and is implemented as a sequence of ASCII graphic screens. gram also installs the user documentation.

non view of the log panel with an option is now supported for Sir r and PVT






## Would you like to test tNavigator?

## Get a demo

## rfdsales@rfdyn.com

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## Already using tNavigator and have questions?

**Contact technical support** 

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