

## APPENDIX B: OPM FLOW RELEASE HISTORY



**APPENDIX TABLE OF CONTENTS**

<b>APPENDIX B: OPM FLOW RELEASE HISTORY.....</b>	<b>2003</b>
B.1 Release 2022-04.....	2006
B.2 Release 2021-10.....	2017
B.3 Release 2021-04.....	2025
B.4 Release 2020-10.....	2031
B.5 Release 2020-04.....	2035
B.6 Release 2019-10.....	2038
B.7 Release 2019-04.....	2042
B.8 Release 2018-10.....	2044
B.9 Release 2018-04.....	2045
B.10 Release 2017-10 Update 1.....	2047
B.11 Release 2017-10.....	2047
B.12 Release 2017-04.....	2047

## B.1 RELEASE 2022-04

The 2022-04 release consists of some new features and various improvements and bug fixes. Highlights for this release include: implementation of the Salt Precipitation Model, several ACTIONX implementation improvements – including support for the COMPSEGS, WELSEGS and WSGVALV keywords in an ACTIONX block, improvements to the CO2STORE model to work with numerical aquifers and to account for thermal effects, support for gas lift optimization for multi-lateral wells, the addition of various SUMMARY vectors, plus various enhancements to the RESTART file to improve compatibility and robustness. Significant work has also been conducted in fixing the number of reported bugs.

When building OPM Flow from source, the default is now be to compile a parallel binary if MPI is installed, this was already the default for the binary packages that were previously distributed. Secondly, support for building OPM Flow with the new current version of DUNE (2.8) has been added.

### New and Deprecated Command Line Options

The major command line changes made for this release are summarized in Table B.1

OPM Flow 2022-04 New And Deprecated Command Line Options			
No.	Variable Name	Description	Default
1	--sched-restart	A Boolean value that determines for a restart run if the case should initialize wells and groups from the historical SCHEDULE section (true), or from the well and group data on the restart file (false).  Note that the commercial simulator always uses data from the restart file (false).	false
1	--enable-tracer-model	A Boolean value set to true or false that turns on (true) or off (false) transport tracer calculations for when tracers have been declared in the input deck.  This option is deprecated (#3717).	
<p><b>Notes:</b></p> <ol style="list-style-type: none"> <li>Cells colored in green in the “No.” column indicate a new command line option or a change to an existing option for this release.</li> <li>Cells colored in red in the “No.” column indicate a deprecated command line option for this release.</li> </ol>			

Table B.1: OPM Flow 2022-04 New and Deprecated Command Line Options

### New Simulator Features and Improvements

In addition to the above the following new features have been added to the simulator:

- The Python version of the opm-parser is used in a number of scripts by some users for parsing specific parts of a data deck. The efficiency of the scripts are improved as the Python version is now aware which section a keyword belongs to and can ignore sections when getting the requested keyword(s). This feature was added in the 2021-10 release but was not documented for that release (#2527).
- ACTIONX implementation improvements include:
  - Support for the MULTX, MULTX-, MULTY, MULTY-, MULTZ and MULTZ- keywords in an ACTIONX block (#3686).
  - Implemented support to access grid property data to enable the COMPDAT, COMPLUMP, etc., type of keywords to work within an ACTIONX bloc (#2828).

- 3) Added support for the COMPSEGS, WELSEGS and WSGVALV keywords within an ACTIONX block (#2849, #2852, and #2885).
  - 4) Added support for the WELTARG keyword within an ACTIONX block (#2892).
  - 5) Added support for the WTMULT keyword within an ACTIONX block (#2906).
  - 6) Added a missing ACTIONX comparison (#2898).
  - 7) Implemented support for the NEXTSTEP keyword in the SCHEDULE section (#3614, #3721 and #3736) as well as support in an ACTIONX block (#2904).
  - 8) Added the NEXT keyword in the SCHEDULE section as an alias for NEXTSTEP (#2902) as well as support for NEXT in an ACTIONX block (#2905).
- 3) Added support for the CO2STORE model to use numerical aquifers (#3711).
  - 4) Enabled the CO2STORE model to account for thermal effects (#3724).
  - 5) Added support for the GRAVITY keyword in the PROPS section (#3670).
  - 6) Improvements on how the well potentials are calculated when the wells are under guide rate control (#3719).
  - 7) Improvements on how the well rates are calculated for when the wells are or not under group control control (#3645).
  - 8) Improve ESmry file output by not writing out empty elements (#2915).
  - 9) Improved how the summary keywords are handled for inter-region summary vectors in ESMRY file, to give a consistent naming convention (#2960).
- 10) RESTART file improvements:
    - 1) Added support for the Extended Network Model (#2857, #2825, #2809, #2808, #2779 and #2804).
    - 2) Added support for reading and writing TRACER data to the RESTART file (#2869, #2861, #2864, #2859, #2855, #3702, #2854, #2879, #3708 and #3718).
    - 3) Added additional entries for well connections (#2427) and improved error reporting when loading RESTART files (#2759).
    - 4) Load and save GCONINJE guide rate injection settings for group water injection to and from the RESTART file (#2888).
    - 5) Read and write GLIFTOPT options to the RESTART file (#2794 and #2777), load and store WLIFTOPT options if enabled for a well (#2791 and #2770).
    - 6) Load and save group efficiency factor values to and from the RESTART file (#2773).
    - 7) Added support for storing and loading group constraints at the field level set by the GCONPROD and GCONINJE keywords (#2814).
  - 11) Added support for the WTMULT keyword in the SCHEDULE section (#2763).
  - 12) Implemented the Salt Precipitation Model. This is an extension of the brine module to deal with salt precipitation/dissolution and allowing primary variable switching between salt concentration and solid(precipitated) see #3729, #3759, #681 and #490. In addition the following keywords have been added and/or updated:
    - 1) The SALTSOL keyword in the PROPS section now supports setting the salt solubility by region (#2593). Note this is an OPM Flow specific keyword used with the simulator's Salt Precipitation model.
    - 2) Added the SALTPVD keyword as part of OPM's Salt Precipitation Model that defines the initial precipitated salt volume fraction versus depth tables for each equilibration region (#2920).

- 3) Implemented PRECSALT keyword in the RUNSPEC section that activates OPM Flow's Salt Precipitation Model (#2595).
- 4) Fixed a unit error with the units for salt concentration on the SALTVD keyword changing the units for the SALTCON parameter from lb/ft<sup>3</sup> to the correct units of lb/stb (#2930).
- 5) Added the SALT keyword to define the initial equilibration salt concentration for all grid blocks and the SALTP keyword to define initial equilibration precipitated salt volume fraction (#2931 and #3774).
- 6) Added the RVW keyword in the SOLUTION section that defines the initial equilibration vaporized water in gas ratio for all grid blocks for use with the Vaporized Water Model (#2968, #3830, #684 and #491).

13) Added support for gas lift optimization for multi-segment wells (#3812).

14) If the simulator fails to find the a cell's saturation pressure (bubble and dew point pressure) then the following message was printed:

Finding the dew point pressure failed for 2 cells [1467066, 1467066]  
 Finding the dew point pressure failed for 5 cells [1467063, 1467063, 1467066, 1467066, 1467066]

This has now be changed to be more readable to:

Finding the dew point pressure failed for 1 cell [(71,89,46)]  
 Finding the dew point pressure failed for 2 cells [(68,89,46), (71,89,46)]

See #3828.

- 15) Added support for gas-water initialization for two-phase runs using PVDG and PVTW keywords in the PROPS section. Two-phase gas-water models will now run; however, the RVCONST and the RVCONSTT keywords are currently unsupported and thus the liquid yields have to be calculated manually (#3838).
- 16) Added support for the WVFPEXP keyword in the SCHEDULE section (#2988 and #3866).
- 17) Added support for LIFTOPT(TSTEP) option that defines the frequency of the gas lift optimization calculations. This was previously documented as implemented but was not. The functionality has now been implemented in this release (#3777).
- 18) Previously, the water only and water only with thermal models were standalone binaries. With this release these models are now incorporated into the main OPM Flow binary (#3892 and #3891).
- 19) The VAPWAT keyword in the RUNSPEC section, that activates the vaporized water phase, is now active for this release for gas-water systems only. Work on the three phase case is currently under way and is expected to be implemented in the next release (#2989 and #2591).

In addition, the following new SUMMARY keywords are now recognized as described by the comments in Table B.2.

No.	Summary Keyword	Comment
1	BGPR and BWPR	Added support for block-level gas (BGPR) and water (BWPR) phase pressures(#3827 and #2967).
2	BNSAT	Implemented block level solvent saturation summary output keyword BNSAT (#3861 and #2986).
3	BTCNFHEA	Added support for the block temperature vector (#2962 and #3820).

No.	Summary Keyword	Comment
4	FSIR, FSIT FSPR, FSPT, FSPC, and FSIP	Added support for salt production rates for the OPM Flow's Salt Precipitation model.
5	GSIR, GSIT, GSPR, and GSPC	Added support for salt production rates for the OPM Flow's Salt Precipitation model. Not GSPT is currently not supported.
6	GWIGR	Previously the simulator would tie reporting of group level Guide Rates to whether or not a group had any guide rates for production; however, this is insufficient for group level injection guide rates. OPM Flow has now been updated to handle group level water injection guide rate reporting on the SUMMARY file via the GWIGR variable ( <a href="#">#3612</a> and <a href="#">#3598</a> ).
7	MSUMBUG MSUMCOMM MSUMERR MSUMMESS MSUMPROB MSUMWARN	In the 2021-04 release the message keywords were recognized by the parser; however, no data associated with these vectors is written to file ( <a href="#">#2234</a> ).  This is still the case.
8	ELAPSED MLINEARS MSUMLINS MSUMNEWT NEWTON NLINEARS NLINSMAX NLINSMIN, STEPTYPE TCPU TCPUDAY TCPUTS TELAPLIN TIMESTEP	Various performance vectors are now supported either declared individually or via the PERFORMA keyword in the SUMMARY section.  The ELAPSED, STEPTYPE, TCPUDAY, TCPUTS and TELAPLIN vectors are written out but all values are set to zero.  See <a href="#">#2953</a> and <a href="#">#3801</a> .
9	R*FR and R*FT	Added support for the following inter-region flow summary vectors:  RGFR, RGFR+, RGFR-, RGFT, RGFT+, RGFT, RGFTG, RGFTL, ROFR, ROFR+, ROFR-, ROFT, ROFT+, ROFT, ROFTG, ROFTL, RWFR, RWFR+, RWFR-, RWFT, RWFT+, and RWFT-  Note that variables ending in a + or - are OPM Flow's implementation of the commercial compositional simulator's variables ( <a href="#">#3811</a> , <a href="#">#3796</a> , <a href="#">#2958</a> , <a href="#">#2945</a> , <a href="#">#2955</a> , <a href="#">#2929</a> , and <a href="#">#2928</a> ).
10	WSIR, WSIT WSPR, WSPT, and WSPC	Added support for salt production rates for the OPM Flow's Salt Precipitation model.
11	WSTAT	Added support for the well status summary variable ( <a href="#">#2853</a> ).

No.	Summary Keyword	Comment
12	WWIRT	In the 2021-04 release support for the WWIRT vector for writing out the water injection rate target was implemented (#2071); however, the field (FWIRT) and Group (GWIRT) vectors were not implemented. A warning message is printed stating the fact.

Table B.2: New SUMMARY Keywords for the 2022-04 Release

## Bug Fixes

The following bug fixes and improvements have been incorporated into this release.

- 1) In models with numerical aquifers, the numerical aquifer cells have large pore volumes which unduly influence the convergence criteria, indicating convergence has been achieved when in fact convergence has not been reached. This has now been corrected (#3638).
- 2) For numerical aquifers, the cell permeability used to compute aquifer to reservoir transmissibilities, did not take into account the MULTX, MULTY and MULTZ values applied to the reservoir cell; these are now taken into account when calculating the aquifer to reservoir transmissibilities (#2919).
- 3) ACTIONX bug fixes include:
  - 1) Fixed a bug associated with the ACTIONX keyword when a well is fully defined in an ACTIONX block and then referenced afterwards in the main deck (#2895).
  - 2) Fixed a bug associated with the ACTIONX keyword when a standard well is fully defined in the main deck and then converted to a multi-segment well in an ACTIONX block (#2895).
- 4) Corrected a bug in the C02STORE model associated with the reference oil density (#3727).
- 5) Gas lift and gas lift optimization issues corrected include:
  - 1) Fixed an incorrect gas lift rate calculation based on IGLR and ALQ (#2807).
  - 2) Corrected an issue with applying gas, oil and water reduction calculation in the gas lift optimization calculation procedure (#3678 and #3673).
  - 3) Fixed an issue when both well and group controls restrict gas lift availability (#3728).
  - 4) Previously, not all groups were considered when reducing oil rates to satisfy oil group limits. This has now been corrected (#3747).
  - 5) Defaulting GLIFOPTT(MAXLIFT) or GLIFOPT(MXGAS) would cause the simulator to throw an error; this has now been rectified (#2884).
  - 6) The VFPPROD(ALQ) default value of I\* is “ ” or undefined, that covers the case when the ALQ variable is not entered, except for when gas lift is employed in the model. When gas lift is active then the default value for ALQ is set to GRAT. Secondly, it is possible to have only the OIL and WATER keywords in the RUNSPEC section and to use gas lift for the wells, without declaring the GAS phase in the RUNSPEC section. If the ALQ and VFPPROD(ALQ-DATA) parameters are absent then the VFPPROD(GFR-DATA) data will be used based on the flowing GOR plus the stipulated gas lift gas. This logic was previously missing from the simulator but is now implemented (#2971, #3833 and #3706).
  - 7) Ensure that group/well guide rates (i.e. the distribution between wells/groups) are updated when gas lift volumes vary during iterations, as defined by LIFTOPT(OPTLIFT) set to YES. This will also reduce the number of oscillations during the Newtonian iterations (#3807).
  - 8) If a well is under a group that is limited by a target, it should use as little gas lift gas as possible. The reduction algorithm will now reduce the gas lift of the well as long as the groups potential is above the groups target (#3795).



- 9) Fixed a bug associated with a group's gas lift artificial lift gas rate plus actual gas production being greater than the group's maximum gas rate as declared via the MXGAS parameter on the GLIFTOPT keyword (#3797).
- 6) Using the GRAVITY keyword in the PROPS section caused an exception to be raised and the simulator to abort. This has been fixed by implementing the GRAVITY keyword (#3670).
- 7) Fixed a bug associated with the default values on the NETBALAN keyword in the SCHEDULE section.
- 8) Added support for PVT extrapolation in the extended black-oil model. Previously, if the required values were outside the values supplied by the input keywords, then the simulator raised an exception and would abort (#680).
- 9) RESTART file bug fixes:
  - 1) Fixed an issue with the field, group, and well level cumulative production curves of solution/free oil and gas not being continuous in a restarted simulation run (#2871).
  - 2) If a well's BHP reference depth is defaulted and there are no connections for the well then the default missing value of  $-1.0E=20$  should be written to the RESTART file, previously this was not the case (#2908). This also resolves issue #2442.
  - 3) Fixed a bug related to writing out tracer data to the restart file (#2878).
  - 4) For a restart run, previously the RPTRST keyword in the SOLUTION section was not retained for the run. This has now been rectified (#2876).
  - 5) The OPM Flow specific PORV\_RC and TMULT\_RC solution arrays were incorrectly marked as commercial simulator compatible arrays, this would cause errors when loading the RESTART file using the commercial simulator. This has now been fixed (#3683).
  - 6) Previously, the cumulative oil and water volumes were set to zero when restarting a simulation. This has now been rectified by using the correct volumes (#2805).
  - 7) Fixed an issue with loading LIFTOPT from the RESTART file (#2790).
  - 8) For the restart group, well and connection data the XWEL keyword items 36 to 39 need to be defined (see Table F.23). The current understanding is that the values are same as items one through three on the same keyword. Secondly, exponent letters need to uppercase ( $1.26E-04$ ) and not lowercase ( $1.26e-04$ ). Both issues have been address in #2975.
- 10) Previously, the RPTSCHED Well Production and Injection reports printed zeros for the field rates and totals, this has now been rectified (#2584 and #2880).
- 11) In parallel runs, applying transmissibility multipliers in the SCHEDULE section would cause an exception to be raised and the simulator to abort. This has now been fixed (#2923).
- 12) SUMMARY output bug fixes:
  - 1) Fixed an issue with the surface gas production volumes having incorrect field units for free and associated (dissolved) gas. This error was specific to runs using field units as opposed to metric units (#2918).
  - 2) Fixed a bug in parallel runs which caused the SUMMARY vectors associated with the free gas, dissolved gas, and the oil and vaporized oil vectors for all objects (field, well, etc.) to be incorrect due to the dissolved phase being under reported. This also effected the free phase volumes as well as Free (Oil, Gas) is calculated from Total (Oil, Gas) - Dissolved (Oil, Gas). Now both sequential and parallel runs give the same results (#3765).
- 13) Incorporated well efficiency, via the WEFAC keyword in the SCHEDULE section, in network calculations. Note that only the default value for WEFAC(WELNETWK) of YES is supported for the Extended Network Model (#3730).

- 14) Fixed WELTARG not supporting the LIFT option (#2881).
- 15) Corrected an issue with how wells are handled for the WECON keyword (#3720).
- 16) If the WRFT keyword was used to report RFT data to the WRFT file and the well had no connections then OPM Flow would write the records to the file. This would cause an issue with OPM ResInsight and other post-processing software attempting to read the resulting WRFT file. OPM Flow no longer writes the records if there are no connections to the well (#2909).
- 17) Using the WTEST keyword to test physically or economically shut-in wells, OPM Flow previously did not check if a well had been manually shut-in via the input deck. This has been corrected such that wells manually shut-in will now not longer be tested (#3713).
- 18) Fixed a bug associated wells prematurely closing due to negative flow potentials (#3834).
- 19) When converting from surface to reservoir rates the simulator needs to solve a 2x2 system of equations using Cramer's Rule, that is  $d = 1 - r_s * r_v$ , where  $d$  is the determinant. If  $d$  is zero the system is singular and the system unsolvable. This should not happen with physical values of  $r_s$  and  $r_v$ , but for unconverged solutions this may happen due to extrapolation of  $r_s/r_v$  tables to unphysical pressures. The fix removes a hard throw and instead ignores the dissolved/vaporized part and tries to continue. Some times this is sufficient to get a more reasonable solution in the next Newton iteration, other times not, and the simulator needs to chop the time step, etc. (#3853 and #3855).
- 20) For the WELSPECS keyword the GRPNAME parameter should not be set to FIELD; however, this was not trapped and resulted in a program exception. This has been rectified by issuing an error message for when GRPNAME is set to FIELD (#2974).
- 21) When multi-segment wells were initially opened the oil and water rates were zero after being scaled because the perforation rates entering calculateSegmentRates routine only had a value for the gas rate and zero for the water and oil rates. This has now been corrected by ensuring the top segment rates will be approximately the same with the well rates after scaling from zero rates from opening the well (#3839).
- 22) Previously wells would per-maturely close due to the economic limits set via the WECON keyword because of inaccurate well potentials and inaccurate ratios (WOR, GOR, etc) caused by negative rates. This has now been corrected (#3851).
- 23) When multi-segment wells are initially opened the well rates and well potentials are zero causing a numerical issue due to creating a singular matrix. This fix ensures we have sensible initial rates etc. for the wells (#3847).
- 24) For multi-segment wells changed from multiplicative to addition when updating the pressure for each segment when the bottom-hole pressure is changed. This is a more robust treatment (#3835).
- 25) If there are no analytical aquifer connections, for example, if the AQUANCON keyword has not been entered or that all the defined connections are invalid, then the simulator would stop. This is still the case but now a more descriptive error message is printed (#2973).
- 26) If there are no cells with valid corner-point geometry, typically caused by using GDFILE to read non-finite data such as all ZCORN = -1.0E+20, then the simulator will throw an exception. Now instead an error message is issued and the simulator terminates gracefully (#3845 and #2979).
- 27) Fixed an issue with being unable to calculate a well's BHP from its THP limit (#3760).
- 28) Under some circumstances a well's BHP constraint may be violated during an iteration cycle, for example, when an injector is opened to give pressure support to the producers it may take a few Newtonian iterations for the pressure support to be propagated and the solution to converge. Before convergence is achieved the simulator may calculate negative potentials resulting in the well being shut-in. This has now been rectified (#3834).
- 29) Check if group and well guide rates have been violated and also ensure that a group's efficiency is accounted for when summing guide rates (#3814).

- 30) When a restarted model uses SKIPREST, there must be either a DATES or TSTEP keywords that correspond exactly to the requested restart time. The previous diagnostic message:

Missing Record in DATES

```
Error: Problem with keyword DATES
In CASE.DATA line 223
At date: 2019-04-18 - scanned past restart data: 2019-04-12
```

Missing Report Step in TSTEP

```
Error: Problem with keyword TSTEP
In PRED_FLOW.DATA line 219
At date: 2019-04-16 - scanned past restart data: 2019-04-12
```

did not offer sufficient information to the user as to what the underlying issue might be. The new message are now:

Missing Record in DATES

```
Error: Problem with keyword DATES
In CASE.DATA line 223
In a restarted simulation using SKIPREST, the DATES keyword must have
a record corresponding to the RESTART time 12-Apr-2019 00:00:00.
Reached time 18-Apr-2019 00:00:00 without an intervening record.
```

Missing Report Step in TSTEP

```
Error: Problem with keyword TSTEP
In CASE.DATA line 219
In a restarted simulation using SKIPREST, the TSTEP keyword must have
a report step corresponding to the RESTART time 12-Apr-2019 00:00:00.
Reached time 16-Apr-2019 00:00:00 without an intervening report step.
```

- 31) If a well has been declared as SHUT via the WCONINJE or WCONPROD keywords but is later activated using the WELOPEN, keyword we must record this status change in the well's internal has\_produced or has\_injected flags as appropriate. Otherwise, the counts of "abandoned" wells (summary vectors [FG]MW[IP]A) will not be correct (#2961).
- 32) If a well under group control is constrained such that the well's THP is below the well's THP limit, then avoid switching to THP control if this results in production or injection rates increasing. For example, if the well's group has a zero rate then we do not want to switch the well control to THP control as this will increase the well's production or injection rate (#3824).
- 33) If an injection well had an insignificant injection rate then the commercial simulator returns zero for the THP regardless of the BHP. OPM Flow now does the same (#3773).
- 34) Fixed an issue with group and well guide rates not being updated after new wells are opened up (#3771).
- 35) In some rare circumstances the WOR/WCT/GOR/GLR limits may be exceeded at the well level but not at any of the individual connections. This can occur due to numerical noise caused by very small rates. If this occurs the simulator will now not shut the well (#3758).
- 36) Previously, the WTEST code only checked the BHP constraints and potentially opened wells limited by a THP constraint. This has now been addressed by checking for both BHP and THP constraints before opening wells using the WTEST facility. (#3803 and #3816).
- 37) If the well residuals contained NaNs (Not a Number) this was counted as an error, now the event is more correctly recorded as unconverged. The simulator behavior remains unchanged (#3867).
- 38) Fix a bug associated with the command line -shut-unsolvable-wells equals true option. The bug did not effect the default behavior (#3863).

- 39) Fixed an error associated with the saturated density in the DRSDTCON keyword ([#3884](#) and [#3878](#)).
- 40) Added the DR, DTHETA and OUTRAD keywords as unsupported keywords with messages to enable the user to debug the input deck ([#3875](#) and [#3883](#)).
- 41) Fixed an issue with checking well potentials, now OPM Flow only checks if wells have negative potentials if the command line `enable-well-operability-check=true`, which is the default behavior ([#3874](#) and [#3885](#)).
- 42) Fixed an issue with initialization when there is no dissolved gas in the model ([#3871](#) and [#3877](#)).
- 43) Stopped wells are wells that are shut-in at the surface and are operable in order to allow cross-flow in the wellbore, as opposed to wells that are shut-in at the sand face. Now stopped wells are changed to shut -in if they cannot converge after repeated time-step chopping. The change makes the well modeling code more robust ([#3890](#) and [#3872](#)).
- 44) Fixed an error associated with Brine model accessing an uninitialized variable if the `enableSaltPrecipitation` Boolean variable is set to false, that is salt precipitation is not enabled ([#691](#) and [#690](#)).
- 45) Fixed an issue with the COMPLUMP keyword with the indices I, J, KI and K2 not having the default value of zero ([#3006](#) and [#3011](#)).

### Known Issues

- 1) The tracer related output to summary file does currently not respect the command line variable - `enable-tracer-mode`, this means we may have the situation in which the input deck specifies tracer output, and the simulator is run without enabling the tracer model (`enable-tracer-mode=false`). In this scenario the trace SUMMARY vector output will consists of irrelevant tracer values.
- 2) The GDFILE keyword in the GRID section loads a grid file in various formats, with the FMTOPT parameter setting the format type of the file. If the variable FMTOPT is omitted then the default is for binary file input for the commercial simulator; whereas, OPM Flow derives FMTOPT from the file extension (\*.EGRID or \*.FEGRID), making FMTOPT superfluous. However, if the extension is lower case then OPM Flow may incorrectly determine the file type. The work around is change the extension to upper case.
- 3) As per previous releases of the radial model, the COORDSYS keyword item three must be set to COMP to complete the circle, this has not been implemented in this release. Also there appears to be a bug for full radial models when a well goes on BHP control that causes the well not to respect the BHP constraint, this eventually causes the well to die prematurely. See [#2640](#) for a discussion on the topic.
- 4) As in previous releases there are some issues with the OPERATE and OPERATER keywords associated with the input parsing; for various reasons a few of the fields require special case treatment in the grid processing, including (at least) MULTZ, PORV and ACTNUM, and for those keywords the OPERATE/OPERATER keyword doe not work.
- 5) For the UDQ ASSIGN operator after the terminating "/" normally any comments can be entered; however, if there is "/" within the comment field, as per:  

```
ASSIGN FUNGLYLD 1.196 / Condensate Yield (63.5/56.7)/(1.0 - 0.065)
```

then the simulator will abort. The work around is to manually place the comment characters "--" after the ASSIGN terminating "/", like so:  

```
ASSIGN FUNGLYLD 1.196 / -- Condensate Yield (63.5/56.7)/(1.0 - 0.06)
```
- 6) At the moment, one cannot initialize tracers using the EQUALS keyword. Instead use the array format, that is the keyword followed by the required number of values, or the TVDP keyword in the SOLUTION section to set the initial tracer concentrations as a function of depth.

- 7) Currently, gas tracers cannot be used if the dissolved gas phase, as per the DISGAS keyword in the RUNSPEC section, is active in the model.
- 8) When using the AQUANCON keyword to declare analytical aquifer connections, using for example:

```

--
--
--              ANALYTIC AQUIFER CONNECTION
--
--          ID          ----- BOX -----    CONNECT  AQF    AQF    ADJOIN
--          NUMBER  I1  I2    J1  J2    K1  K2    FACE    INFLX  MULTI  CELLS
AQUANCON
          1          3  54    117  142    1  30    J+      1*    1*    1* /
          2          83 131     20  48    1  30    J-      1*    1*    1* /
          2          53  84     2   19    1  30    J-      1*    1*    1* /
/

```

Then if there are invalid aquifer connections OPM Flow will issue a warning message for each invalid connection. If there are numerous invalid connections because of the irregular shape of the reservoir edges then the simulator will take a long time to write out all the invalid connections. The work around is to more precisely define the aquifer connection data (#2993).

- 9) Running the BRINE model or the PRECSALT model in parallel will cause the simulator to about with an exception. The solution is to run the cases in sequential mode instead (#3768).
- 10) There is a potential issue with left-handed grids that may cause the simulator to stop due to how the check for left-handed versus right-handed coordinate systems is performed in the corner-point processing code, which implicitly assumes that all pillars have well-defined, unique top-point coordinates. However, in some cases the pillar top points may be at the same coordinate location if there are no active cells along a particular pillar. Secondly, although OPM ResInsight may load the input grid, the display will be incorrect. Currently there is no work around for this except for re-generating the grid from the static model (#3896).
- 11) In some cases when the program stops the error message is written to the terminal but not to the \*.PRT or \*.DBG files. This is because the failing code is not aware of the C++ logging system. For example, this will occur if there is an error in parsing the grid data as the corner-point processing code is written in C and at the moment cannot call the C++ logging system. (#3896).
- 12) The summary vector RTIPTHEA, that defines the energy in-place between the initial and the current time for regions, is not supported unlike the FTIPTHEA and BTIPTHEA vectors. Secondly, the error message:

```

Warning: Problem with summary keyword RTIPTHEA
In RSM-THERMAL.data line 492
FIP region FIPHEA not defined in REGIONS section - RTIPTHEA ignored

```

is incorrect, as the message indicates that it is being treated like a named region, as per the FIP keyword, when it is actually a SUMMARY vector (#3870).

- 13) If there are cells that are very distorted, which can occur near fault planes, then the simulator may abort because it cannot calculate the pore volume of such cells. The work around is to re-generate the grid in the static model, taking care that the cells around the fault planes are more or less orthogonal (#2992 and #3770).
- 14) Currently the OPERATOR keyword in the EDIT section does not work with the DEPTH, TRANX, TRANY and TRANZ property arrays (#2994 and #748).
- 15) If a standard well is fully declared in an ACTIONX block which is then activated at a later date, and later the well is modified to be a multi-segment well using the WELSEGS and COMPSEGS keywords,

then this will cause the simulator to abort with an assert failure. The solution to this issue is to not use this type work flow in declaring wells (#2891 and #2895).

- 16) Although the ACTIONX EXIT command works as expected, it does not write out the requested RSM file at the end of the run. However, the other SUMMARY and RESTART files are written out (#2877).
- 17) Although the GCONSUMP keyword in the SCHEDULE section is fully implemented as documented, it is not possible to verify the output as the associated SUMMARY vectors are not written out, that is the SUMMARY sales gas vectors FGSR, FGST, GGSR and GGST, and fuel vectors FGCR, FGCT, GGCR, and GGCT have not been implemented (#2679).
- 18) There are small differences in the behavior of the NEXTSTEP keyword in the RUNSPEC section between OPM Flow and the commercial simulator that remain unresolved (#3745).

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