From: William Burch
Sent: Wednesday, May 12, 2010 5:33 PM
To: Fred Ng
Subject: RE: (RequestID:11852) Clarification of GOR model in OLGA-ABC

No, I did some digging.

Ole has put a smaller equivalent ID at the wellhead and applied a choke at the top of the BOPs. If he removed them, I'd bet he'd be in the ballpark too.

Bill

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From: Fred Ng
Sent: Wednesday, May 12, 2010 5:15 PM
To: William Burch
Subject: FW: (RequestID:11852) Clarification of GOR model in OLGA-ABC

still get a GOR less than 3000 ..... beats me. Looks like the DNV PVT file gets close on GOR, but the oil rate is a lot higher than Ole's. May be I am too simple minded ..... could it be that Ole's gas rate is just hard wired to mutiply the oil rate by GOR, rather than a gas rate generated by simulation? He has it exactly at 3000.

From: William Burch
Sent: Wednesday, May 12, 2010 12:52 PM
To: drillbenchsupport@sptgroup.com
Cc: kurt.mix@bp.com; Fred Ng; Inge Mosti; David Barnett; kek@sptgroup.com; agnes.scott@sptgroup.com; lmn@sptgroup.com
Subject: RE: (RequestID:11852) Clarification of GOR model in OLGA-ABC

Dewayne,

I was in meetings all day yesterday.

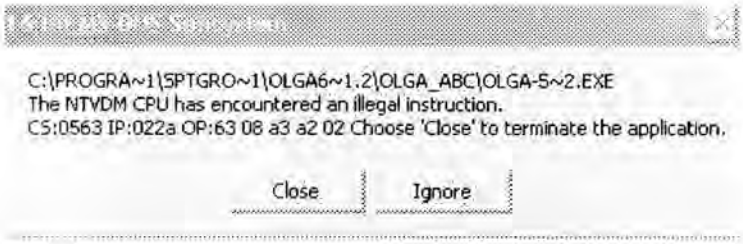
I've run the model with the BP PVT file you included using the original OLGA exe file and still get a GOR less than 3000 with the 3,650 psi backpressure (which was what Ole Rygg used originally from the reported flowing wellhead temperature.) Each simulation was allowed to run 6 hours (360 minutes) and is based on the seafloor case where the riser is acting like a 70 ft long 12" ID diverter. Each PVT file was renamed to Black oil.tab as suggested. The default Volatile oil.tab was run as selected.

All files are attached in the .zip file.

Model	*PVT*	*Oil Rate*	*Gas Rate*	*GOR*

		(bopd)	(mmscf/d)	(scf/stb)
OLGA-WellKill	Ole Rygg (source unknown)	~38,300	~107	2,794
OLGA-ABC 5.3	BP-Macondo_050310_fixed_2000bar_500C.tab	~63,500	~110	1,735
OLGA-ABC 5.3	DNV Custom PVT (based on MDT sample 18,124 ft)	~64,500	~170	2,635
OLGA-ABC 5.3	Ole Rygg (source unknown)	~63,700	~111	1,742
OLGA-ABC 5.3	Volatile oil.tab	~85,500	~102	1,193

OLGA-5.3.txt renamed to OLGA-5.3.exe as instructed did not work. See warning below.



Bill

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From: drillbenchsupport@sptgroup.com [mailto:drillbenchsupport@sptgroup.com]
Sent: Tuesday, May 11, 2010 11:55 AM
To: William Burch
Cc: kurt.mix@bp.com
Subject: [WARNING - NOT VIRUS SCANNED](RequestID:11852) Clarification of GOR model in OLGA-ABC

Hello again Bill,

Inge and I have spoken this morning (Houston time) to help coordinate and keep things moving as quickly and productively as possible for your critical case. Apparently I clicked a button wrong, because you can run ABC for more than a 30-minute Unloading Period to help get the final "lined out" Gas and Liquid Rates - as Inge did in his own test runs overnight for us in US CDT. (Sorry about my mis-statement yesterday!)

I am ABSOLUTELY glad to construct a customized "temporary replacement" Property Table for WWC to exactly match your current case as Inge proposes, in case WWC feels that replacing the default "Black oil.tab" in the ABC Fluids subfolder is the best workaround.

In fact, my office neighbor Dr. Lee Norris already has BP's PVTsim database that PRECISELY describes the BP Full Well Stream (with ~3000 GOR, just as you were told to expect!), as he is working on the Riser Flow / Hydrates / Heating problems for the line they would attach to "the top of the can". (Yes, the same "can" that Hydrated Up over the weekend, because they hadn't yet found a way pre-connect it and first start pumping heated fluid down around it before setting it in place.)

Therefore, I am also attaching such a *.tab file that covers the exact same overall 1-2000 bara and 0-500 C P/T

range as OLGA ABC's native "Black oil.tab", but that now includes the exact "Macondo" / "MC 252 #1 336126-44 Fi T = 243F" full wellstream fluid model that Dr. Norris received from BP in a PVTsim database model that BP Flow Assurance Engineers transmitted to him on May 3. FYI, its inherent GOR seems to be 3175 SCF/STB.

However, even as I was writing the above, the Chief Scientist of our Norway Headquarters Research and Methods Development Team (who is apparently also now helping to "team tackle" this ABC problem) sent an important internal note. This note reminds his SPT Group colleagues that the particular OLGA Calculation Engine version currently being used by ABC contained a bug that failed to respect any user-specified "GORST" subkey of the Native OLGA "WELL" keyword.

That very same Native OLGA Input appears to you as the "Gas oil ratio" field on the Reservoir Input panel of ABC. So, THIS is why ABC Version 1.01 is insensitive to any GOR input different from the inherent (or built-in) GOR of the selected Black Oil, Volatile Oil, Dry Gas, or Methane *.TA.

So, we now know the cause of that problem (in Version 5.3 of the OLGA Calculation Engine). And, Dr. Norris and I also know that BP users of Native OLGA accept the subsequent OLGA Calculation Engine Version 5.3.2 (which fixes this GORST bug) as their Corporate Standard version of the OLGA Calculation Engine. I have made a special run with this version, obtaining a higher, input-sensitive Gas-to-LIQUID-Ratio of 2738 SCF/STB TOTAL LIQUID. Once we subtract off for the 10% water cut in the case you had attached, this will bring us VERY CLOSE to the 3000 SCF/STB Gas-to-OIL Ratio that was specified in its Reservoir inputs (2737*10/9 = 3041).

Therefore, I can now use this information to offer you a second, more-generalized alternative solution, which you could also use for other cases with different GOR's. However, you should note that this alternative will be a bit less accurate (in Gas and Liquid Density and resulting Buoyancy effects on required Kill Mud Weight, etc) than substituting this EXACT BP WELL FLUID into one of ABC's pre-defined *.TAB File Names (i.e., Black oil.tab).

If you choose to implement this second, more-generalized alternative (as a immediate GOR-input-sensitive workaround, until an official ABC update can be issued by SPT Group Software Development), you will need to take the following steps:

1) Rename "olga-5.3.exe" in the OLGA_ABC folder of your software installation location to something like "olga-5.3.original" or olga-5.3.bak".

2) Save the attached file which I have RENAMED to "olga-5.3.exe" into that SAME OLGA_ABC folder, keeping this exact name so that the ABC V1.01 Windows Interface can "find it". (FYI, this file actually contains the same "olga-5.3.2.exe" approved by BP for their official use of "Native OLGA" in all Flow Assurance projects - simply renamed by me in order to trick the ABC V1.01 interface into using it.)

3) Close and re-open OLGA ABC. Now your same cases should "magically" become GOR-input-sensitive at runtime. Note that the same GOR extrapolation rules I decribed yesterday will still apply - regardless of OLGA Engine Version. This means that you'll be MUCH better off to switch to the default, as-installed Volatile oil.tab (with its inherent GOR of 2656 SCF/STB) to your desired GOR of 3000, rather than sticking with the default, as-installed 597 SCF/STB Black oil.tab and effectively demanding that OLGA "stretch" this fluid to a GOR 5 times higher (which would REALLY have much different Liquid Density and especially Vapor Density than this model will predict).

I will now be out of the office for the rest of Tuesday afternoon, but back on Wednesday morning. If I can do anything further to assist you in this matter, please advise. Or, if you have any urgent questions in my absence

this afternoon, please call the SPT Group Houston office and ask to speak with my Flow Services Manager, Ian Roberts. Ian is fully briefed on what I'm suggesting to you here, and should be able to help "move the ball" if urgently needed before my return.

Best Regards,

Dewayne Anderson
Drillbenchsupport@sptgroup.com

Hi Bill,

I confirm the findings of Dewayne. If I set the GOR to 2656 scf/stb (as the actual GOR in the volatile oil PVT file), and no water cut, I get a GOR at surface of 2656 give or take a few (the water cut is part of the liquid flow at surface and will influence the ratio). However when increasing the GOR I do not get a corresponding change in the simulations, so I'm passing this on to development in order to find the reason.

I suggest that if you need a PVT with a given GOR for your current project, you should contact Dewayne (dan@sptgroup.com) and he can create a PVT file with a specific GOR close to what you require, that you can use in the simulations (copy the .tab file into following path C:\Program Files\SPT Group\OLGA 6.2\OLGA_ABC\Fluids (or similar if the program is installed somewhere else than c:\) and rename the file to "Black oil.tab" and select the black oil composition when you run the simulations. This will now use the custom made PVT composition (specify GOR the same as in the PVT file).

I hope this will provide a sufficient workaround for you while we investigate the GOR input.

Kind regards,

Inge

> Hello Bill,
>
> My name is Dewayne Anderson - a Flow Services Consultant at SPT Group's Houston Office. I have been working to throughout the day on Monday May 10 (Houston time) to bring a different "Native OLGA" focus and help "team tackle" your high-priority OLGA ABC Question / Output QC Problem, with the following further progress:
>
> I first assessed the Unloading Period – noting that graphs were not completely lined out on either liquid rate or gas rate by end of the previously-established 30 minutes. Tried increasing to 60 minutes Unloading Period (after Reset, to re-activate these input fields). Although seemingly accepted by the Drillbench ABC graphical interface, my longer Unloading Period was ignored/overridden by the current OLGA ABC v1.01 software at runtime, with no apparent means to achieve any value in excess of 30 minutes unloading time within the OLGA ABC "input expert". I will check this further with my colleagues in SPT Group Software Development.
>
> Fluid Type / GOR – Selecting Black Oil fluid type and specifying 3000 SCF/STB GOR do not seem to be the most compatible combination of inputs. As the name suggested, I found that the inherent GOR of Black oil.tab was only 560 SCF/STB (less than 1/5 of your required GOR for the current case). This combination of inputs causes OLGA to make some very long extrapolations, assuming (the same) multi-component liquid and vapor compositions that

wouldn't REALLY exist in equilibrium with each other at this much higher actual GOR. Runtime and output discrepancies can result from some necessary internal math (as OLGA attempts to shift up or down in Absolute GOR, while maintaining the same Partial Derivative of Gas Fraction with respect to Temperature and assuming the same Gas/Oil Gravities and Phase Fluid Properties). Such a compromise model is a rough approximation at best, in a case that really "wants" a different *.TAB file.

To assess the potential inconsistencies due to combining the 560-GOR Black Oil with the 3000 GOR input, I went on to evaluate OLGA ABC's next built-in alternative – the Volatile Oil * TAB file (and Fluid Type). FYI, its inherent GOR is 2656 SCF/STB, MUCH closer to your desired 3000 SCF/STB. Now with this *.TAB file (aka, OLGA ABC Fluid Type), my own check of Surface Outlet GOR - calculated from (Gas Flowrate Out / Liquid Flowrate Out) after OLGA ABC v1.01's fixed 30-Minute Unloading Period increased to a MUCH-CLOSER 2440 SCF/STB (by comparison to 1411 SCF/STB for the original case with all other inputs the same, except for its Black Oil fluid type).

Recognizing the importance of this matter, I wanted to write now and report this progress as of EOD Monday Houston time. My colleagues in Norway (such as Inge) will now also be able to inspect my findings, and may perhaps have further input overnight (for us in US CDT).

However, you will immediately be able to achieve the same degree of improved consistency that I reported above, simply by switching Reservoir / Fluid Type from Black Oil to Volatile Oil (presuming the same GOR input of 3000 SCF/STB).

I hope this will already get you most of the way to your QC goal. A longer Unloading Period could get us the rest of the way there (by "lining out" to the asymptotic limits of both Oil and Gas Outlet Rates). However, that "last 20%" consistency improvement would either require some additional OLGA ABC input that I am so far unable to find for you, or perhaps a custom run on the (complex, Expert Level) Native OLGA Interface.

Please Forward to all other interested parties at WWC and/or BP.

Best Regards (and Best Wishes from all of us here at SPT Group),

Dewayne Anderson
Principal Consultant, Flow Services
SPT Group Houston
Drillbenchsupport@sptgroup.com

Igne,

We were using the black oil standard definition PVT file whichcome with the base installation. Attached is the DML file from theblowout at surface – it should be the easiest to have at standardconditions as the exit point is surface. I get 62,300 bopd and 88 MMscf/dwith 292 lbm/s from the reservoir. If I divide the gas rate by the oilrate at

surface, I get a GOR of 1412 scf/stb not the entered 3000 scf/stb. If I assume the gas rate is correct, my oil flow rate should be 29,300 stb.

This is true for any simulation – not just the current wellcontrol situation.

Bill

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From:

Bill, since you have the latest run files, please send them tolnge. Thanks.

From:

Hi Fred and William,

Can you please send us the input file and the PVT file that you areusing (set up with the PI and GOR that causes the discrepancy). We are givingthis high priority and will respond as soon as possible.

Kind regards,

Inge

Recieved by private mail

Fra: Fred Ng <fng@wildwell.com>
Dato: 10. mai 2010 00.30.49 GMT+02.00
Til: William Burch <bburch@wildwell.com>
Kopi: Inge Mosti <inge.mosti@sptgroup.com>, David Barnett<dbarnett@wildwell.com>, John Hatteberg <jhatteberg@wildwell.com>,Monte Leicht <mleicht@wildwell.com>, C Scott Jortner<SJortner@wildwell.com>
Emne: RE: (RequestID:11852) Clarification of GOR model in OLGA-ABC

If OLGA-Well Kill and OLGA-ABC both use OLGA, wonder why there would be a differenceother than unit conversion? Not sure about my new girlfriend OLGA if shechanges her mind like that.

By the way, I meant to say "I know the pressure ratio is way more than2"

From: William Burch
Sent: Sunday, May 09, 2010 4:53 PM
To: Fred Ng
Cc: Inge Mosti; David Barnett; John Hatteberg; Monte Leicht; C Scott Jortner
Subject: Re: (RequestID:11852) Clarification of GOR model in OLGA-ABC

Surface or subsea. Ole thinks it's either unit conversion issue (OLGA works inSI and converts to field) or the code is wrong because OLGA doesn't calculatevolume rates from the reservoir but mass rate then calculates the volumes.

Sent from my iPhone

On May 9, 2010, at 4:29 PM, "Fred Ng"<fng@wildwell.com> wrote:
If it's one of the subsea blowout scenarios, may be ABC did not correctgas rate for water column back pressure to standard atmosphere? I know thepressure ratio is way more than 2, but not sure how much Z factor comes in.Just a wild guess, from a non-petroleum engineer.

From: William Burch
Sent: Sunday, May 09, 2010 1:55 PM
To: Inge Mosti
Cc: David Barnett; John Hatteberg; Monte Leicht; C Scott Jortner; Fred Ng
Subject: RE: (RequestID:11852) Clarification of GOR model in OLGA-ABC

Inge,

It's not that simple on the GOR. Ole Rygg is here and we are comparingOLGA WellKill to OLGA-ABC numbers and I'm hitting the same wall with theGOR. Ole's oil/gas rates are for example 38,000 bopd and 107 MMscf whichif you divide the numbers, is approximate 3000 GOR. Makes sense.

Kurt Mix and I have a model (based on the same PVT file that Ole is using) of53,500 bopd and 93 MMscf which is 1700 scf/stb. How can I input 3000 scf/stband get 1700 scf/stb on my rates?

Thanks for your help,

Bill

> Hi William,
>
> The model will assume that the PI given is gas PI for the compositionsmethane and dry gas.
>
> For the compositions volatile oil and black oil the model will assume thatthe PI given is the oil PI.
>
> For the PI given (gas or oil depending on the composition) GOR isused to calculate the mass rate influx of the gas and oil phase from thereservoir at reservoir conditions based on the PVT properties as definedin the composition .tab file.
>
> I am suggesting for development to clarify the following in the input windowto make it clear what is used:
>
> It should be stated in the input if the PI required is gas or oil.
>
> The unit should change accordingly to the phase.
>
> This should be implemented in the next release.
>
> Kind regards,
>
> Inge
>
> > TheGOR value entered into OLGA-ABC has been seriouslyquestioned bypeer-review. Can you please provide Kurt Mix (