Sensitivities initial STARS run

As many of the parameters I used were pretty uncertain, it is interesting to examine how variation of these parameters affects the results. But note that all these runs are done with reservoir voidage balance, so that the effect of large pressure variation is not exercised.

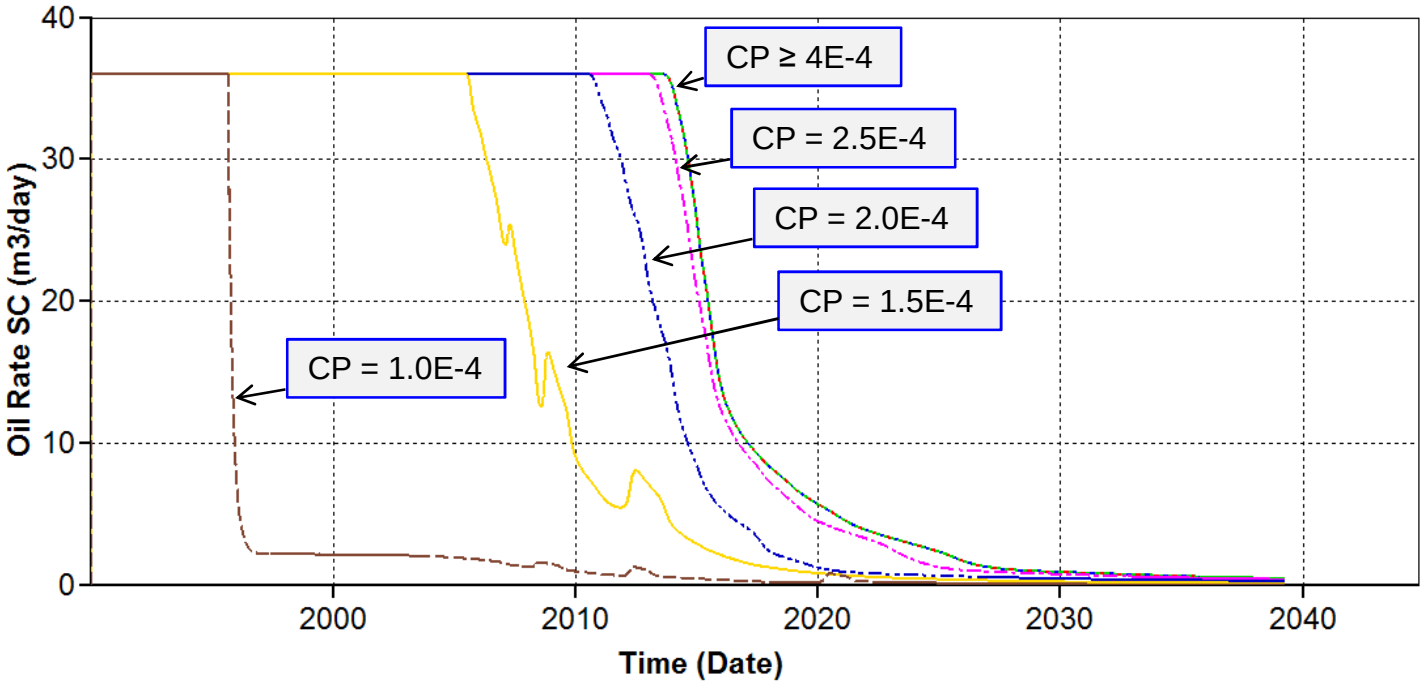
- **Molecular weight oil (CMM)**. Changing CMM (oil) from 0.15 to 0.08 had a slight effect on the q_o-curve (steeper decline). Large effect on GOR, refcase had GOR ~57, now increased to ~107.
- **Molecular weight gas (CMM)**. CMM(gas): 0.022 → 0.05. Same effect on q_o-curve (slight change, but even steeper than case above). No change in GOR or q_g.
- **Liquid oil compressibility (CP)**. CP(oil): 1.0E-7 → 5E-5. Very large effect on oil rate: q_o^{RC} was reduced to only 6.1 m^3/D, and the plateau lasted 13 years longer than in the refcase. GOR didn't change.
  Also tried a decrease of CP(oil), to 1.0E-8. This was not noticeably different from the refcase.
- **Liquid gas compressibility (CP)**. See separate section later
- **SURFLASH**. K_SURF 'DeadOil ' must be < 1, else crazy results.
  But varying K_SURF (within "permitted" ranges (Oil 0-1, Gas > 1) didn't have any effect at all, so to me it appears that SURFLASH doesn't work as described
- **Gas density (MASSDEN)** Was 0.66, tested 0.01 – 10, saw no difference at all
- **Initial gas mole fraction (x_2).** Saw no effect of changing it (Very surprising).
- **KV3.** Was 3.45. Varying KV3 had minimal effect on q_o (whether ST or RC), but rather large effect on GOR. (KV3 = 6 reduced GOR by about 50%, KV3 = 2 increased GOR from 57 to 140.
  So this is a parameter that can be used to tune GOR without affecting oil rate too much.

Sensitivity on Liquid gas compressibility

By a "coincidence" I discovered I'd got a warning on the CP(gas) = 0.00925 I had used. The warning was of the type; "WARNING: This parameter is normally in the range 0 – 1.0E-3."

As I was pretty uncertain of this value anyway, this was a hint that my value was a little off. So chose a value of 1.0E-4, more or less at random, but well within the "permitted" range. Disaster!
Clearly this was one sensitive parameter, so made a series of runs, with
CP = 1E-3, 8E-4, 6E-4, 4E-4, 2.5E-4, 2E-4, 1.5E-4, 1.25E-4, and 1E-4.

The figure below shows oil rate for these cases varying (liquid) gas compressibility.



Two features are striking here, the obvious one that even small variations in CP has a huge effect on the results, signifying that it's critical to get the CP(gas) correct. The other observation is that we are left with a very small acceptable range of variation for CP. At CP < 2E-4 results start to appear unphysical, and the computations look unstable. As 1E-3 was the upper limit for the "normal range", that leaves us with something like $2.5E\text{-}4 \leq CP \leq 1E\text{-}3$, which is a rather tough restriction, considering the great selection of gases out there.

The reservoir pressure is comparable for all cases $CP \geq 2E\text{-}4$, but the "disturbing" case CP = 1.5E-4 experiences a pressure drop down to around 20000 kPa, where it stabilizes (due to well constraints). STARS obviously has problems handling the reservoir voidage for this situation.

REMARK: When testing these models, it has been implicitly assumed that pressure variation is small (that's the point of using reservoir voidage). So this case, with pressured decreasing from 35000 kPa to 20000 kPa can also suffer from our component description being wrong for such a pressure range. (This will be examined in later blogs).