North Sea Oil No.1 (NS-OIL-1)

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June 2019

Introduction

- NS-OIL-1 is a PVT Report (work performed by Core Laboratories, Aberdeen) of a UK North Sea Oil Fluid, analysed in the mid-2000s
- The well was sampled by Bottom Hole Sampler (four BHS samples) and Surface Separator Test; the latter was not taken forward for analysis
- All of the BHS samples were flashed in the laboratory and the compositions of the resulting vapour and liquid streams were measured. These streams were then mathematically recombined to determine the composition of the wellstream.
  - The Recombination Process is discussed at length in Section 6.2 of the SPE Monograph on Phase Behavior by Whitson and Brule
- One of the BHS samples was then subject to CCE, DLE, Two Separator Tests and a Hybrid CCE/DLE to measure oil viscosity
- **It has been assumed that all the relevant QA/QC tests have been performed on the reported data.** This is an essential step before beginning EoS analysis to prevent the classic, "Garbage-In, Garbage-Out"!
  - Again, see Whitson & Brule (and elsewhere) for a discussion of relevant PVT QA/QC

Selected BHS Composition

- Note Sample reports zero mol% (< 0.01!) H2 & H2S
- Non-zero neo-Pentane
- PNA split for C7, C8, C9 & C10
- Plus Fraction of C36+

Compositional Analysis of Bottomhole Sample NS-OIL-1 to C36+

Calculated Residue Properties	
C_{7+}	
Mole%	33.00
Molecular Weight (g mol-1)	243
Density at 60°F (g cm-3)	0.8699
C_{11+}	
Mole%	22.51
Molecular Weight (g mol-1)	305
Density at 60°F (g cm-3)	0.8926
C_{20+}	
Mole%	10.30
Molecular Weight (g mol-1)	431
Density at 60°F (g cm-3)	0.9327
C_{36+}	
Mole %	2.43
Molecular Weight (g mol-1)	670
Density at 60°F (g cm-3)	1.0193
Calculated Whole Sample Properties	
Average mole weight (g mol-1)	96.4

Compositional Analysis of Bottomhole Sample NS-OIL-1 to C36+

	Component	Mole %	Weight %
H_2	Hydrogen	0.00	0.00
H_2S	Hydrogen Sulphide	0.00	0.00
CO_2	Carbon Dioxide	1.84	0.84
N_2	Nitrogen	0.39	0.11
C_1	Methane	49.09	8.17
C_2	Ethane	6.70	2.09
C_3	Propane	3.76	1.72
IC_4	i-Butane	0.58	0.35
nC_4	n-Butane	1.71	1.03
C_5	Neo-Pentane	0.00	0.00
IC_5	i-Pentane	0.62	0.46
nC_5	n-Pentane	0.97	0.73
C_6	Hexanes	1.34	1.20
	M-C-Pentane	0.44	0.38
	Benzene	0.60	0.49
	Cyclohexane	0.65	0.57
C_7	Heptanes	1.21	1.25
	M-C-Hexane	0.86	0.88
	Toluene	0.85	0.82
C_8	Octanes	1.50	1.78
	E-Benzene	0.17	0.18
	M/P-Xylene	0.64	0.70
	O-Xylene	0.23	0.26
C_9	Nonanes	1.38	1.83
	1,2,4-TMB	0.23	0.29
C_{10}	Decanes	1.73	2.55
C_{11}	Undecanes	1.63	2.49
C_{12}	Dodecanes	1.51	2.53
C_{13}	Tridecanes	1.60	2.91
C_{14}	Tetradecanes	1.41	2.78
C_{15}	Pentadecanes	1.55	3.31
C_{16}	Hexadecanes	1.26	2.90
C_{17}	Heptdecanes	1.12	2.75
C_{18}	Octadecanes	1.11	2.88
C_{19}	Nonadecanes	1.02	2.78
C_{20}	Eicosanes	0.88	2.50
C_{21}	Heneicosanes	0.80	2.41
C_{22}	Docosanes	0.72	2.27
C_{23}	Tricosanes	0.66	2.18
C_{24}	Tetracosanes	0.60	2.07
C_{25}	Pentacosanes	0.56	1.99
C_{26}	Hexacosanes	0.51	1.88
C_{27}	Heptacosanes	0.46	1.79
C_{28}	Octacosanes	0.42	1.70
C_{29}	Nonacosanes	0.42	1.76
C_{30}	Triacontanes	0.37	1.62
C_{31}	Hentriacontanes	0.36	1.58
C_{32}	Dotriacontanes	0.31	1.44
C_{33}	Tritriacontanes	0.29	1.37
C_{34}	Tetratriacontanes	0.27	1.30
C_{35}	Pentatriacontanes	0.24	1.21
C_{36+}	Hexatriacontanes Plus	2.43	16.92
	Totals :	100.00	100.00

Note: 0.00 means less than 0.005.

CCE

- Note Tres = 285 degF
- Note Pinit and Pbub (Sat Pres)
- Pay attention to the small-print at bottom of page

Constant Composition Expansion at 285°F

Pressure (psig)		Relative Volume (1)	Density (g cm-3)	Instantaneous Compressibility (psi-1 x 10-6) (2)	Y-function (3)
7500		0.9570	0.6951	11.24	
7000		0.9626	0.6911	11.96	
6500		0.9685	0.6868	12.77	
6000		0.9749	0.6823	13.69	
5723	**Reservoir pressure**	**0.9787**	**0.6797**	**14.25**	
5500		0.9819	0.6775	14.74	
5000		0.9895	0.6723	15.96	
4800		0.9927	0.6701	16.51	
4700		0.9943	0.6690	16.79	
4600		0.9960	0.6679	17.09	
4500		0.9977	0.6667	17.40	
4400		0.9995	0.6655	17.71	
4371	**Saturation pressure**	**1.0000**	**0.6652**		
4362		1.0006			
4343		1.0018			
4326		1.0029			
4318		1.0034			
4312		1.0038			
4260		1.0073			
4161		1.0142			
3995		1.0270			
3711		1.0525			3.374
3271		1.1043			3.211
2684		1.2089			2.992
2023		1.4202			2.742
1573		1.6858			2.570
1195		2.0836			2.423
865		2.7381			2.293

(1) Relative Volume = V / Vsat ie. volume at indicated pressure per volume at saturation pressure.
(2) Instantaneous compressibility = (V2-V1) / V1 x 1/(P1-P2)
(3) Y-function = (Psat - P) / ((Pabs)(V/Vsat - 1)).

DLE

- Note Tres = 285 degF
- Note Pbub (Sat Pres) [same as CCE]
- Pay attention to the small-print at bottom of page

Differential Vaporisation at 285°F

Pressure (psig)	Solution Gas-Oil Ratio Rs(1)	Relative Oil Volume Bod(2)	Relative Total Volume Btd(3)	Density (g cm-3)	Deviation Factor (Z)	Gas Formation Volume Factor (4)	Incremental Gas Gravity (Air = 1.000)
4371	**1012**	**1.621**	**1.621**	**0.6652**		**Saturation Pressure**	
3700	839	1.541	1.706	0.6817	0.940	0.00534	0.746
2700	598	1.432	1.962	0.7066	0.924	0.00718	0.732
1700	394	1.337	2.597	0.7319	0.930	0.01144	0.745
1000	262	1.276	3.922	0.7496	0.952	0.01980	0.773
500	168	1.229	7.223	0.7644	0.972	0.03987	0.845
200	102	1.192	16.919	0.7754	0.987	0.09706	1.021
0	0	1.114		0.7864			2.168
	At 60°F =	1.000					

Residual Oil Properties

Density of residual oil	0.8760	g cm-3 at 60°F
API	29.9	

(1) GOR in cubic feet of gas at 14.73 psia and 60°F per barrel of residual oil at 60°F.
(2) Volume of oil at indicated pressure and temperature per volume of residual oil at 60°F.
(3) Volume of oil plus liberated gas at indicated pressure and temperature per volume of residual oil at 60°F.
(4) Volume of gas at indicated pressure and temperature per volume at 14.73 psia and 60°F.

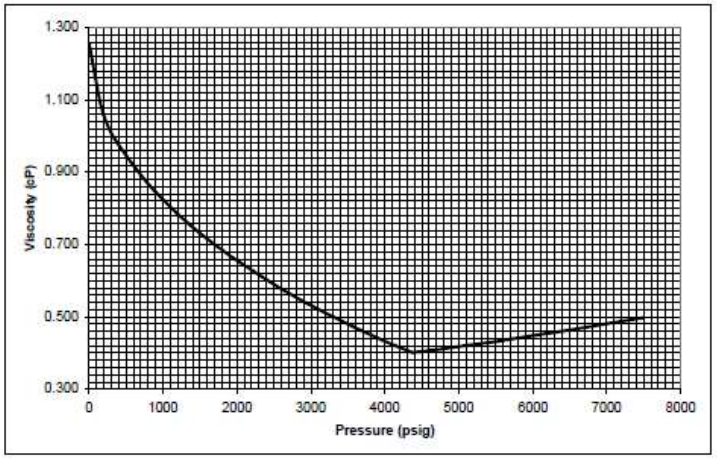
Viscosity: CCE/DLE Hybrid

- Note Tres = 285 degF
- Note Pbub (Sat Pres) [same as CCE]
- Pay attention to the small-print at bottom of page
  - Namely, Gas Viscosity is Calculated, not Measured!

Reservoir Fluid Viscosity Data at 285°F

Pressure (psig)		Oil Viscosity (cP)	Calculated Gas Viscosity (cP) (1)	Oil/Gas Viscosity Ratio
7500		0.498		
7000		0.481		
6500		0.464		
6000		0.448		
5723	**Reservoir pressure**	**0.439**		
5500		0.432		
5000		0.418		
4800		0.412		
4700		0.409		
4600		0.407		
4500		0.404		
4400		0.402		
4371	**Saturation pressure**	**0.401**		
3700		0.461	0.0231	20.0
2700		0.566	0.0197	28.7
1700		0.700	0.0171	40.9
1000		0.824	0.0156	52.8
500		0.947	0.0145	65.3
200		1.058	0.0134	79.0
0		1.257		

Reservoir Fluid Viscosity v Pressure at 285°F



(1) Calculated using the method of Lee, Gonzales and Eakin, JPT, Aug 1966.

‘Separator’ Tests

- OK, first ‘Separator’ Test is Single Flash straight to standard conditions [0 psig, 60 degF]
- Separator Test has two stages [second at standard conditions]
- Both tests report change from reservoir saturated conditions [Pbub, Tres] to give ‘total’ GOR and FVF
- Again, read the small print, especially about stage GORs

Atmospheric Flash Data

Pressure (psig)	Temperature (°F)	Gas-Oil Ratio Rs (1)	Oil Density (g cm-3)	Shrinkage Factor Bo (2)	Flashed Gas Gravity (Air = 1.000)
4371	**285**	**815**		**1.496**	
0	60		0.8631 (API = 32.3°)	1.000	0.777

(1) GOR in cubic feet of gas at 14.73 psia and 60°F per barrel of residual oil at 60°F
(2) Volume of undersaturated oil at 4371 psig and 285°F per volume of residual oil at 60F

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G.1

Separator Test Data

Pressure (psig)	Temperature (°F)	Gas-Oil Ratio (1)	Gas-Oil Ratio Rsfb (2)	Oil Density (g cm-3)	Formation Volume Factor Bofb (3)	Separation Volume Factor (4)	Gas Gravity of flashed gas (Air = 1.000)
4371	**285**	-		**0.6652**	**1.477**	**Saturation Pressure**	
600	104	580	634	0.8207		1.094	0.660
0	60	171	171	0.8602 (API = 32.8°)		1.000	1.008
			805				

(1) GOR in cubic feet of gas at 14.73 psia and 60°F per barrel of oil at indicated pressure and temperature.
(2) GOR in cubic feet of gas at 14.73 psia and 60°F per barrel of stocktank oil at 60°F.
(3) Volume of saturated oil at 4371 psig and 285°F per volume of stocktank oil at 60°F.
(4) Volume of oil at indicated pressure and temperature per volume of stocktank oil at 60°F.

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H.1

Preparing Data for PVTfree

- *PVTfree* doesn't have a Graphical User Interface (GUI). Rather, users must prepare an ASCII (plain text) file of keywords and data, akin to that required by the commercial reservoir simulators
  - Although there is an extensive manual for *PVTfree* which details how to write an input file, along with example datasets, we note most users just want to 'dive-in'
- We have written an Excel spreadsheet with VBA macros called SetupPVTfree.xlsm to help novice users. NS-OIL-1 will be analysed using this spreadsheet.
- Open the spreadsheet and from the Master worksheet (w/s), click the 'Locate PVTfree.py' button and use the Open-File popup to locate the PVTfree.py file (the 'main')
- If there is already data in the spreadsheet (multiple w/s other than Master), click the 'Clear All' button to remove all these other w/s
- The data shown on the previous slides (3-7) has been copied & pasted from the PDF report into a new w/s (called srfwork – I'm srf, and its my *work* sheet!) and re-formatted to make it easier to copy & paste into the subsequent w/s created by SetupPVTfree.xlsm

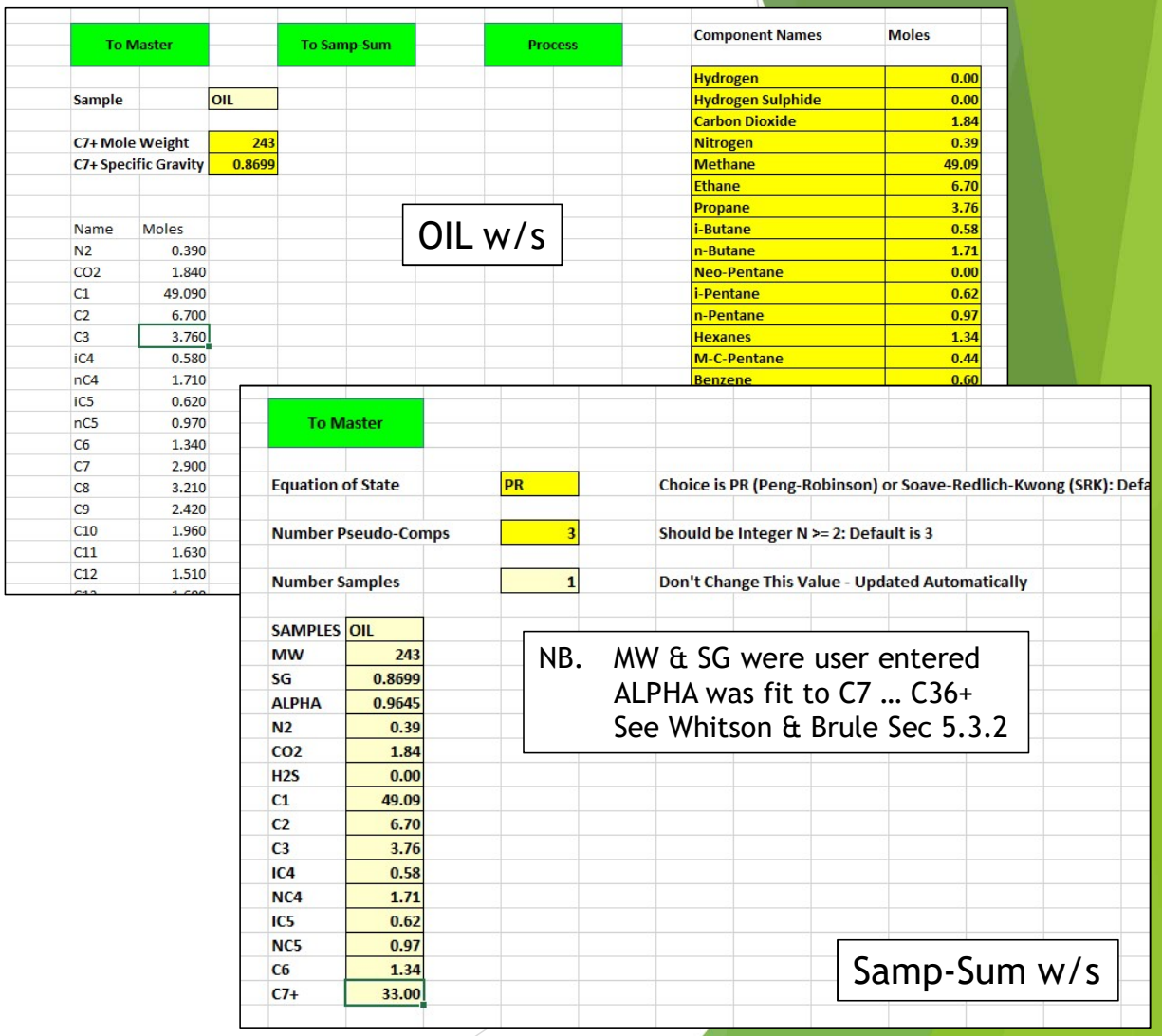
Example srfwork w/s

- Ensure Composition sums to 100.0
  - Many don't!
- Check spelling
  - C17 (yellow) should be Heptadecanes
  - Edit this before copying to New Sample w/s
- Note the units
  - Bg on DLE ???
  - Think its rcf/scf
  - If there's no obvious unit, its probably 'dim' (dimensionless)

				CCE		285 degF		DLE		285 degF						Visc	285		Single Stage Flash				
	Hydrogen	0.00		Pres	Rel Vol	Oil Dens		Pres	GOR	Bo	BT	Oil Dens	Gas Zfac	Gas FVF	Gas Grav	Pres	Oil Visc		Pres	Tres	GOR	Oil Dens	Bo	Gas Grav
	Hydrogen Sulphide	0.00		psig	dim	gm/cm3		psig	svf/stb	rb/stb	rb/stb	gm/sm3	dim	???	dim	psig	cP		psig	degF	scf/stb	gm/cm3	rb/stb	dim
	Carbon Dioxide	1.84		7500	0.9570	0.6951		4371	1012	1.621	1.621	0.6852				7500	0.498		4371	285	815		1.496	
	Nitrogen	0.39		7000	0.9626	0.6911		3700	839	1.541	1.706	0.6817	0.940	0.00534	0.746	7000	0.481		0	60		0.8631		0.777
	Methane	49.09		6500	0.9685	0.6868		2700	598	1.432	1.962	0.7066	0.924	0.00718	0.732	6500	0.464							
	Ethane	6.70		6000	0.9749	0.6823		1700	394	1.337	2.597	0.7319	0.930	0.01144	0.745	6000	0.448		Separator Test					
	Propane	3.76		5723	0.9787	0.6797		1000	262	1.276	3.922	0.7496	0.952	0.01980	0.773	5723	0.439							
	i-Butane	0.58		5500	0.9819	0.6775		500	168	1.229	7.223	0.7644	0.972	0.03987	0.845	5500	0.432		Pres	Tres	GOR	Oil Dens	Bo	Gas Grav
	n-Butane	1.71		5000	0.9895	0.6723		200	102	1.192	16.919	0.7754	0.987	0.09706	1.021	5000	0.418		psig	degF	scf/stb	gm/cm3	rb/stb	dim
	Neo-Pentane	0.00		4800	0.9927	0.6701		0	0	1.114		0.7864			2.168	4800	0.412		4371	285	806	0.6652	1.477	
	i-Pentane	0.62		4700	0.9943	0.6690										4700	0.409		600	104	634	0.8207	1.094	0.66
	n-Pentane	0.97		4600	0.9960	0.6679										4600	0.407		0	60	171	0.8602		1.008
	Hexanes	1.34		4500	0.9977	0.6667										4500	0.404							
	M-C-Pentane	0.44		4400	0.9995	0.6655										4400	0.402							
	Benzene	0.60		4371	1.0000	0.6652										4371	0.401							
	Cyclohexane	0.65		4362	1.0006											3700	0.461							
	Heptanes	1.21		4343	1.0018											2700	0.566							
	M-C-Hexane	0.86		4326	1.0029											1700	0.700							
	Toluene	0.85		4318	1.0034											1000	0.824							
	Octanes	1.50		4312	1.0038											500	0.947							
	E-Benzene	0.17		4260	1.0073											200	1.058							
	M/P-Xylene	0.64		4161	1.0142											0	1.257							
	O-Xylene	0.23		3995	1.0270																			
	Nonanes	1.38		3711	1.0525																			
	1,2,4-TMB	0.23		3271	1.1043																			
	Decanes	1.73		2684	1.2089																			
	Undecanes	1.63		2023	1.4202																			
	Dodecanes	1.51		1573	1.6858																			
	Tridecanes	1.60		1195	2.0836																			
	Tetradecanes	1.41		865	2.7381																			
	Pentadecanes	1.55																						
	Hexadecanes	1.26																						
Spelling!!	Heptdecanes	1.12																						
	Octadecanes	1.11																						
	Nonadecanes	1.02																						
	Eicosanes	0.88																						
	Heneicosanes	0.80																						
	Docosanes	0.72																						
	Tricosanes	0.66																						
	Tetracosanes	0.60																						
	Pentacosanes	0.56																						
	Hexacosanes	0.51																						
	Heptacosanes	0.46																						
	Octacosanes	0.42																						
	Nonacosanes	0.42																						
	Triacontanes	0.37																						
	Hentriacontanes	0.36																						
	Dotriacontanes	0.31																						
	Tritriacontanes	0.29																						
	Tetratriacontanes	0.27																						
	Pentatriacontanes	0.24																						
	Hexatriacontanes Plu	2.43																						
		100.00																						

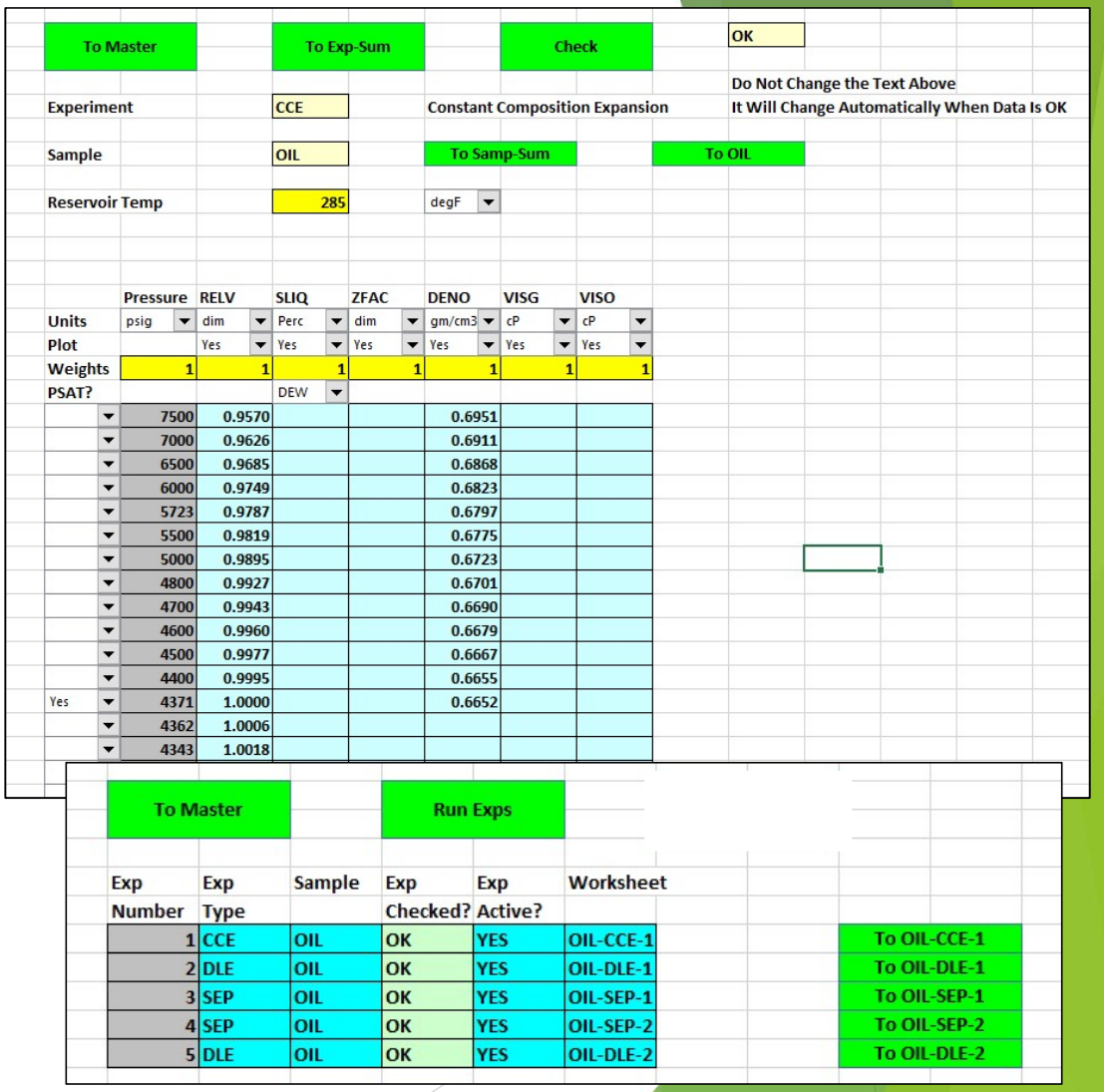
Add Sample

- From the Master w/s, click the ‘Add Sample’ button. A popup will ask to provide the name for the sample
  - I got lazy and called it ‘OIL’
  - We create two w/s called OIL & Samp-Sum (Sample-Summary)
- Fill the cells coloured yellow
- When ready, click ‘Process’ button
- If OK, will add a column on the Samp-Sum w/s
  - Can change EoS by typing SRK
  - Can change #Pseudos
- If not OK, fix the problem!
  - You’re on your own! Trace problem in VBA



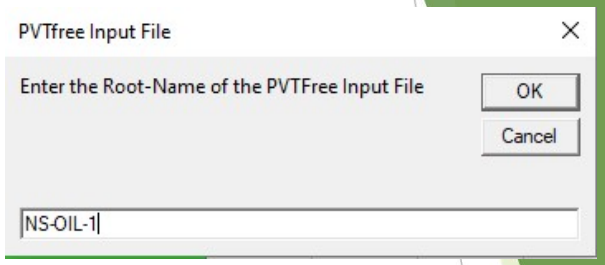
Add Experiments

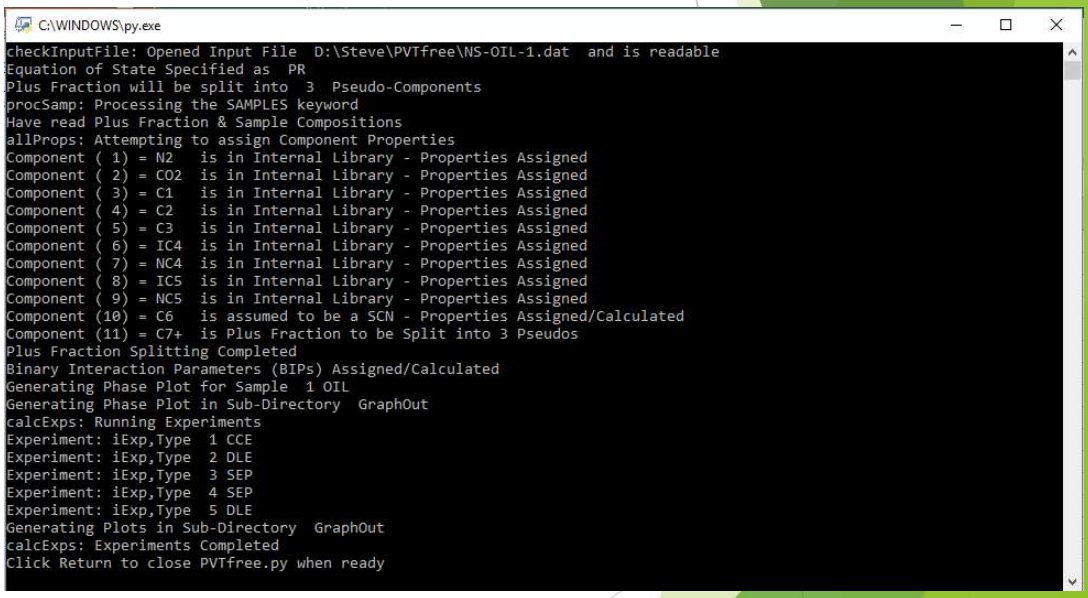
- From the Master w/s, click the ‘Add Experiment’ button. A popup will ask to provide the type of experiment required and for which sample (we only have one – ‘OIL’)
  - CCE, CVD, DLE, SEP, SAT, FLS, SWL or GRD
- Copy the relevant columns of data
- Select units from the dropdowns
- For CCE, CVD & DLE, mark one row as being the PSAT pressure
- Plots required? Use dropdowns
- Don’t forget the Tres & its units
- When all OK, click ‘Check’ button
- If all OK, review on the Exp-Sum w/s (Experiment Summary)



Run Experiments

- Once all experiments (five) have been checked (‘OK’ in Exp Checked? Column), click ‘Run Exps’ button on Exp-Sum
- Supply the root-name of the data file to be created, and
- Windows Command Prompt (CMD or DOS) should open and the file should run
  - Click Return to close CMD
- Study the input file (here NS-OIL-1.dat) and output file (here NS-OIL-1.out)





Input File

```
--================================================
-- Fluid Initialisation
--================================================

INIT

-- Equation of State: PR (Peng-Robinson) or SRK (Soave-Redlich-Kwong)

EOS     PR

-- Number of Pseudo-Components To Be Split

SPLIT   3

-- Sample Definitions

SAMPLES   OIL
MW        243.00
SG        0.8699
ALPHA     0.9645
N2        0.3900
CO2       1.8400
C1        49.0900
C2        6.7000
C3        3.7600
IC4       0.5800
NC4       1.7100
IC5       0.6200
NC5       0.9700
C6        1.3400
C7+       33.0000

ENDINIT
```

```
--================================================
-- Experiments
--================================================

EXP

CCE
  samp  OIL  Tres  285.00  degF  Sliq  DEW
PLOT                          Yes       Yes
                 PRES       RELV      DENO
                 psig        dim     gm/cm3
              7500.00     0.9570    0.6951
              7000.00     0.9626    0.6911
              6500.00     0.9685    0.6868
              6000.00     0.9749    0.6823
              5723.00     0.9787    0.6797
              5500.00     0.9819    0.6775
              5000.00     0.9895    0.6723
              4800.00     0.9927    0.6701
              4700.00     0.9943    0.6690
              4600.00     0.9960    0.6679
              4500.00     0.9977    0.6667
              4400.00     0.9995    0.6655
PSAT          4371.00     1.0000    0.6652
              4362.00     1.0006    0.0000
              4343.00     1.0018    0.0000
              4326.00     1.0029    0.0000
              4318.00     1.0034    0.0000
              4312.00     1.0038    0.0000
              4260.00     1.0073    0.0000
              4161.00     1.0142    0.0000
              3995.00     1.0270    0.0000
              3711.00     1.0525    0.0000
              3271.00     1.1043    0.0000
              2684.00     1.2089    0.0000
              2023.00     1.4202    0.0000
              1573.00     1.6858    0.0000
              1195.00     2.0836    0.0000
               865.00     2.7381    0.0000
```

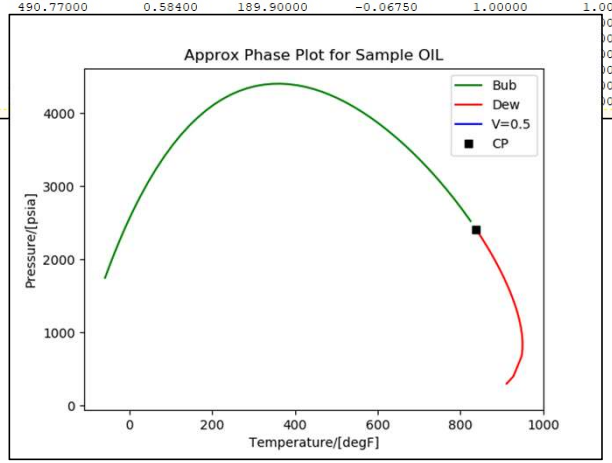
```
DLE
  samp  OIL  Tres  285.00  degF
PLOT                          Yes       Yes       Yes       Yes       Yes
                 PRES        BO       GOR      DENO      ZFAC      GGRV
                 psig     rb/stb    scf/stb   gm/cm3       dim       dim
PSAT          4371.00    1.6210 1012.0000    0.6652    0.0000    0.0000
              3700.00    1.5410  839.0000    0.6817    0.9400    0.7460
              2700.00    1.4320  598.0000    0.7066    0.9240    0.7320
              1700.00    1.3370  394.0000    0.7319    0.9300    0.7450
              1000.00    1.2760  262.0000    0.7496    0.9520    0.7730
               500.00    1.2290  168.0000    0.7644    0.9720    0.8450
               200.00    1.1920  102.0000    0.7754    0.9870    1.0210
                 0.00    1.1140    0.0000    0.7864    0.0000    2.1680

SEP
  samp  OIL
PLOT                          Yes       Yes       Yes       Yes
                 PRES       TEMP       BO       GOR      DENO      GGRV
                 psig       degF     rb/stb    scf/stb   gm/cm3       dim
PSAT          4371.00     285.00    1.4910  815.0000    0.0000    0.0000
                 0.00      60.00    0.0000    0.0000    0.8631    0.7770

SEP
  samp  OIL
PLOT                          Yes       Yes       Yes       Yes
                 PRES       TEMP       BO       GOR      DENO      GGRV
                 psig       degF     rb/stb    scf/stb   gm/cm3
PSAT          4371.00     285.00    1.4770  806.0000    0.6652    0.000
               600.00     104.00    1.0940  634.0000    0.8207    0.660
                 0.00      60.00    0.0000  171.0000    0.8602    1.008
```

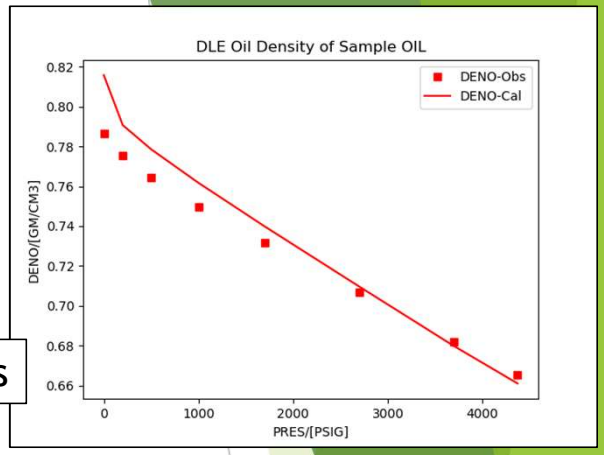
```
DLE
  samp  OIL  Tres  285.00  degF
PLOT                          Yes
                 PRES       VISO
                 psig         cP
              7500.00     0.4980
              7000.00     0.4810
              6500.00     0.4640
              6000.00     0.4480
              5723.00     0.4390
              5500.00     0.4320
              5000.00     0.4180
              4800.00     0.4120
              4700.00     0.4090
              4600.00     0.4070
              4500.00     0.4040
              4400.00     0.4020
PSAT          4371.00     0.4010
              3700.00     0.4610
              2700.00     0.5660
              1700.00     0.7000
              1000.00     0.8240
               500.00     0.9470
               200.00     1.0580
                 0.00     1.2570
```

Output File plus Plots in GraphOut Sub-Directory

```
Plus Fraction (C7+) Properties

Sample         OIL

Mol Wt      243.000
Spec Grv    0.86990
Alpha       0.96450

   Comp          Mol Wt        Tcrit        Pcrit        Vcrit        Zcrit        AcenF
   Name        [lb/lbmol]      [degR]       [psia]    [ft3/lbmol]     [dim]        [dim]
==========================================================================================
N2              28.01300    227.27000    493.00000      1.44300      0.29168      0.04500
C1              16.04300    343.04000    667.80000      1.59000      0.28843      0.01200
CO2             44.01000    547.57000   1070.60000      1.50500      0.27420      0.23100
C2              30.07000    549.76000    707.80000      2.37000      0.28433      0.09100
C3              44.09700    665.68000    616.30000      3.25000      0.28038      0.14500
IC4             58.12400    734.65000    529.10000      4.20800      0.28241      0.17600
NC4             58.12400    765.32000    550.70000      4.08000      0.27357      0.19300
IC5             72.15100    828.77000    490.40000      4.89900      0.27012      0.22700
NC5             72.15100    845.37000    488.60000      4.87000      0.26229      0.25100
C6              84.00000    937.44116    476.73080      5.77503      0.27367      0.28735
C7+P1          117.10160   1071.10229    419.57351      7.35349      0.26842      0.37661
C7+P2          239.54899   1361.57033    242.39197     14.05243      0.23311      0.72507
C7+P3          500.00000   1650.87335    133.02216     24.14542      0.18129      1.26071

   Comp          Tboil      Spec Grav     Parachor     Vol Shift    Mult-OmegaA  Mult-OmegaB
   Name        [degR]     [wrt Wat=1]      [dim]        [dim]        [dim]        [dim]
==========================================================================================
N2             139.27000      0.47000     41.00000     -0.19270      1.00000      1.00000
C1             200.98000      0.33000     77.00000     -0.15950      1.00000      1.00000
CO2            350.37000      0.50700     70.00000     -0.08170      1.00000      1.00000
C2             332.19000      0.45000    108.00000     -0.11340      1.00000      1.00000
C3             416.00000      0.50800    150.30000     -0.08630      1.00000      1.00000
IC4            470.57000      0.56300    181.50000     -0.08440      1.00000      1.00000
NC4            490.77000      0.58400    189.90000     -0.06750      1.00000      1.00000
IC5                                                                              0000
NC5                                                                              0000
C6                                                                               0000
C7+P1                                                                            0000
C7+P2                                                                            0000
C7+P3                                                                            0000
```

C7+ => C7+P1, C7+P2, C7+P3





Or study Plots

```
 Experiment Number 2 run on Sample[1] = OIL

 At Reservoir Temperature of                285.000 degF

 Observed   Saturation Pressure (Psat) =    4371.000 PSIG
 Calculated Saturation Pressure (Psat) =    4337.597 PSIG

  PRES          BO-OBS        BO-CAL        GOR-OBS       GOR-CAL       DENO-OBS      DENO-CAL
  PSIG          RB/STB        RB/STB        SCF/STB       SCF/STB       GM/CM3        GM/CM3
==========================================================================================
4371.00000      1.62100       1.65745    1012.00000    1053.75226       0.66520       0.66097
3700.00000      1.54100       1.56402     839.00000     860.96860       0.68170       0.67973
2700.00000      1.43200       1.43988     598.00000     608.46651       0.70660       0.70959
                              1.33443     394.00000     397.98422       0.73190       0.73982
                              1.26705     262.00000     267.93743       0.74960       0.76172
                              1.21810     168.00000     178.54752       0.76440       0.77859
                              1.18236     102.00000     119.65210       0.77540       0.79072
                              1.06818       0.00000      -0.00000       0.78640       0.81584

==========================================================
 Separator Test (SEP) Experiment
==========================================================

 Experiment Number 3 run on Sample[1] = OIL

 Observed   Saturation Pressure (Psat) =    4371.000 PSIG
 Calculated Saturation Pressure (Psat) =    4337.597 PSIG

  PRES          TEMP          LSep  VSep    BO-OBS        BO-CAL        GOR-OBS       GOR-CAL
  PSIG          DEGF          Stg#  Stg#    RB/STB        RB/STB        SCF/STB       SCF/STB
==========================================================================================
4371.00000    285.00000         1     1      1.49100       1.53001     815.00000     896.04781
   0.00000     60.00000         0     0      0.00000       1.00000       0.00000     896.04781
```

Compare Calculated (CAL) and Observed (OBS)

And from here …

- You will have to edit the Input File and run from the Command Prompt (type CMD in Search Box bottom left)
  - There's a runit.bat (will need editing) to save typing …
- For example, Regress using Plus Fraction Parameters
- Study effect of regress in Out file and regress file (here NS-OUT-1.reg)
- Consider adding non-unity weighting factors with WEIG keyword in each experiment
- Consider removing observed data (set to zero) which are biasing the regression but don't add 'value'
- Consider alternate regression variables, i.e.
  - Ω_A-Multipliers, Ω_B-Multipliers and BIPs
  - T_c, P_c, etc.
- See *PVTfree* manual for details
- Also Generating Black Oil Tables, Grouping and Output for Compositional Simulators

```
--================================================
-- Regression
--================================================

REG

-- Don't include 2nd DLE which contains Viscosity Data

EXP    CCE DLE:1 SEP:1 SEP:2

-- Regress the MW, SG & ALPHA of the C7+
-- PVTfree will group C7+P1, C7+P2 & C7+P3 -> C7+
-- Adjust C7+ values and re-split

VAR
  MPLUS  OIL
  SPLUS  OIL
  APLUS  OIL
ENDVAR

ENDREG
```

```
readReg: Starting Regression with  5  Experiments Defined
readReg: Of Which  4  Experiments Are Active
lineSearch: fun0,grd0,lamB,fun1    0.04222 -5.073e-02    1.00000    0.01598
lineSearch: fun0,grd0,lamB,fun1    0.01598 -8.337e-04    1.00000    0.01555
lineSearch: fun0,grd0,lamB,fun1    0.01555 -3.404e-07    1.00000    0.01555
Regression converged!
```