PVT Properties in the IGI Property Model

The IGI property model shipped with version 2.3 of the software sees the introduction of a new PVT property model relevant to geochemistry. This means that the significant parameters determined from a range of PVT tests can now be captured in p:IGI+ project files or added to Metis databases. If geochemistry and PVT samples align, fluid characteristics from a PVT lab can be compared to bulk fractionation (SARA) and molecular/gas parameter values measured in a geochemical lab.

__PVT__: An abbreviation of Pressure, Volume and Temperature that refers to the study of how hydrocarbon systems behave with respect to pressure, temperature, volume and composition, often associated with achieving optimal recovery.

At the highest level, the IGI property model stores data generated from fluid sample analysis conducted at specialised geochemistry and PVT laboratories or derived from on-site production test results, e.g. GOR/CGR from flow rate parameters and oil density, etc.
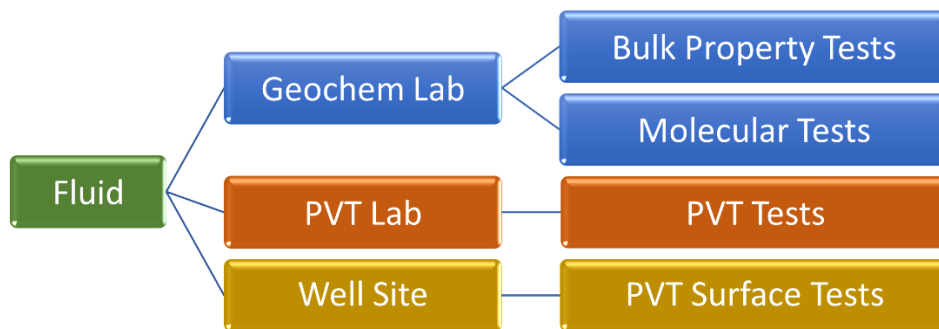

__Figure 1:__ Illustration of the analytical routes open to a fluid sample after sampling. At a high level the relation between geochemistry and PVT analyses is shown. A fluid can be split and subjected to analysis at multiple locations. Note: Other tests are available at a geochemical lab other than bulk character & molecular.

The **Bulk** group now contains fluid behaviour properties (Oil density, GOR, oil content properties e.g. %S, %N etc.) reported specifically from a geochemical laboratory.

Taking account of the analysis location, well site surface test results are captured in the **PVT-Flow** group, while results from tests undertaken in a PVT laboratory on collected fluids are reported in the appropriate **PVT** groups (Figure 1).

The renamed **PVT** (formerly BulkPVT) and **PVT-GC** groups are the main PVT property groups containing parameters derived from laboratory tests.

Types of PVT data stored in the .PVT & .PVT-GC groups
Reservoir pressure & temperature character
Saturation pressure at reservoir temperatures
Oil and gas densities
Gas solubility in reservoir oil (GOR)
Shrinkage (volume) factors of oil and gas from reservoir to surface conditions (FVF)
Wax analysis
Fluid compositional analysis

__Table 1:__ A list of important reservoir fluid properties which are derived from laboratory PVT experiments. Core PVT properties are highlighted with a yellow background.

The source of core PVT properties (Table 1) in the PVT group is designated to come from the routinely run validation single-stage separation test (aka Atmospheric Flash test).

The depressurised oil and gas fractions obtained from the single-stage separation test are used to conduct fluid composition analysis. By preference, the PVT-GC property group should be used to store the normalised molar fractions for the **recombined reservoir fluid**. The phase used should be stored in the **Comp phase.PVT-GC** property. Along with the capacity to store information on individual molecules, the property group also supports a range of plus faction compositions.

Where core PVT properties (Table 1) are derived from alternative laboratory PVT tests, test-specific property groups have been provided. An unknown test group is also available where the laboratory test is unknown:

- **PVT-Msep:** Multistage separator test.
- **PVT-Dlib:** Differential liberation test.
- **PVT-Un:** Data provided with no test source information.

PVT Any Properties
GOR PVT.Any
Oil dens.Any
Oil dens pSat.Any
Oil dens pReserv.Any
FVF pSat.Any
FVF pReserv.Any
Gas Grav.Any

Where properties occur across several property groups, we have added **.Any** properties. The preference order where samples have values for a property in several groups is PVT >> PVT-MSep >> PVT-DLib >> PVT-Un. Care has been taken not to mix values from well site tests with those from laboratory PVT tests (Tabel 2).

Table 2: A list of the core PVT laboratory properties which exist in the .Any property group.

Oil density (**Oil dens.PVT**) is routinely reported at atmospheric conditions, equivalent to stock tank oil. Provision in the model has also been made for oil density values reported at saturation and reservoir pressure (both at reservoir temperature); **Oil dens pSat** & **Oil dens pReserv** respectively. Accommodation of values routinely reported relative to different pressures also applies to a sample's formation volume factor.

The gas-oil-ratio (GOR) property has several aliases in PVT analysis based on whether data has been measured from PVT on-site tests or laboratory tests (GOR, GLR, GVF, Rs, GOR/Rs). The model uses the common term **GOR** throughout its naming, with aliases to assist property discovery and linking where appropriate.

Fluid viscosity values are recorded in the **PVT-Visc** group. Sample viscosity is given its own group, as the group contains three separate schemas depending on the test set-up used. The three schemas present are:

1) Viscosity is reported relative to saturation and reservoir pressure with the temperature fixed at the reservoir value (reported in the **tReserv.PVT** property)
2) Viscosity is reported relative to saturation and reservoir pressure with the temperature fixed at a value different to that in the reservoir (reported in the **Alt Temp.PVT-Visc** property)
3) Viscosity is reported relative to user-defined pressure and temperature values (reported in the **User Temp.PVT-Visc** & **User Pressure.PVT-Visc** properties).

In the **Fluid-Interp** group, users can record fluid contamination levels and assign PVT samples to a fluid class. This property group also allows the user to record an associated comment and interpretation confidence level.

Figures 2 and 3 provide a full overview of the PVT property groups & properties. We hope you find the new PVT model extension useful.
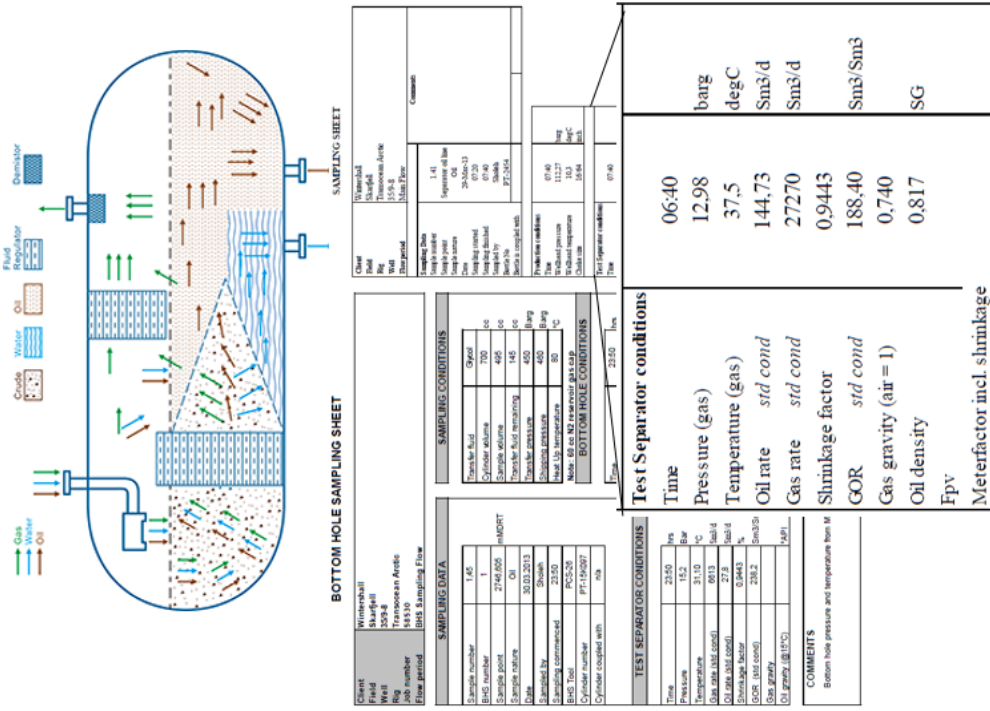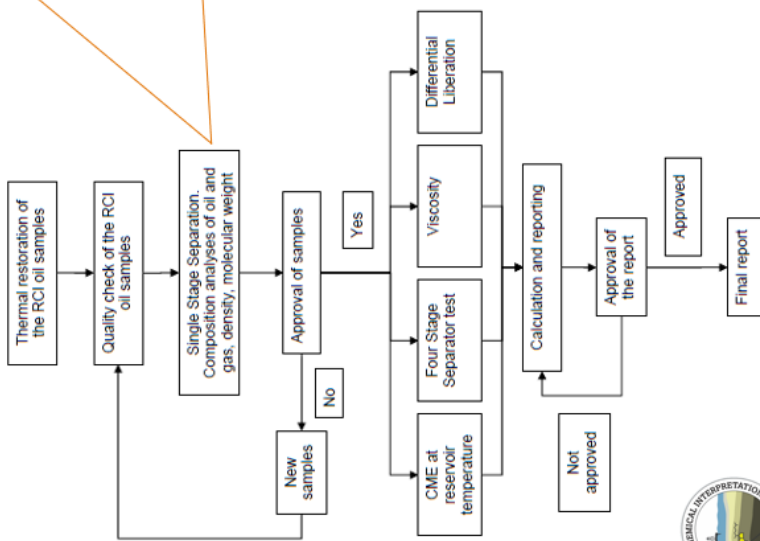
Figure 2: *A detailed record of the properties associated with A) the PVT-Flow property group (PVT well site) and B) the Bulk property group (fluid character determined in a geochemical laboratory).*

PVT Model

PVT Lab Tests

- Shipped samples are exposed to a host of tests

New PVT Property Model

PVT

pReserv
tReserv
pSat
pSat type
GOR
GOR corr
Oil dens
Oil dens corr
Oil dens pReserv
Oil dens pSat
FVF pReserv
FVF pSat
Gas Grav
Compress pSat
Z-factor pSat
%Wax
Wax Meltp
Wax Setp
TAN
CloudPt
Pour Pt
CloudPt+
Pour Pt+
Treatment+
CloudPt++
Pour Pt++
Treatment++
Wet heat
Dry heat
Lab
Date
Lab#
Lab Container#
Company#
Prep
Method
Eqp
Std cond
Run#
Lab comment
Quality
Data file
Hist data src
Hist entry date

PVT-Msep

GOR
Oil dens
Oil dens pSat
Oil dens pReserv
FVF pReserv
FVF pSat
Gas Grav
Date
Prep
Method
Eqp
Lab comment
Quality
Data file

PVT-Dlib

GOR
Oil dens
Oil dens pSat
Oil dens pReserv
FVF pReserv
FVF pSat
Gas Grav
Date
Prep
Method
Eqp
Lab comment
Quality
Data file

PVT-Un

GOR
Oil dens
Oil dens pSat
Oil dens pReserv
FVF pReserv
FVF pSat
Gas Grav
Date
Prep
Method
Eqp
Lab comment
Quality
Data file

PVT-GC

Comp phase		
Mol wt	C21s	Wetness (C1-C4)
H2	C22s	Wetness (C1-C5)
H2S	C23s	Balance
N2	C24s	Character
CO2	C25s	Bernard
nC1	C26s	C1/C2
nC2	C27s	C1/C3
nC3	C28s	C1/C4
iC4	C29s	C1/C5
nC4	C30s	C2/C3
22DMC3	C31s	C3/C4
iC5	C32s	(C4+C5)/(C1+C2)
nC5	C33s	C4(i)/C4(n)
CyC5	C34s	C5(i)/C5(n)
2MC5	C35s	C1 + N2
C6s	C36+	HC (C2-C6) + CO2
MCyC5	C36+ mol wt	SF(nC3-nC5)
Benz	C36+ dens	SF(C10s+)
CyC6	SumComp	Ideal GOR
2MC6	C7+	Ideal CGR
C7s	C7+ mol wt	Date
MCyC6	C7+ dens	Prep
Tol	C10+	Method
224TMC5	C10+ mol wt	Lab comment
C8s	C10+ dens	Quality
ECyC6	C11+	Data file
EBenz	C11+ mol wt	
m-pXyl	C11+ dens	
oXyl	C12+	
iC9	C12+ mol wt	
C9s	C12+ dens	
135TMeBenz	C14+	
C10s	C14+ mol wt	
C11s	C14+ dens	
C12s	C20+	
C13s	C20+ mol wt	
C14s	C20+ dens	
C15s	C24+	
C16s	C24+ mol wt	
C17s	C24+ dens	
C18s	C30+	
C19s	C30+ mol wt	
C20s	C30+ dens	

PVT-Visc

Visc pReserv
Visc pSat
Alt Temp
Visc altT pReserv
Visc altT pSat
User Temp
User Pressure
User Visc
Lab
Date
Lab#
Lab Container#
Company#
Prep
Method
Eqp
Std cond
Run#
Lab comment
Quality
Data file
Hist data src
Hist entry date

Fluid-Interp

Interp Cmnt
Contam
%Contam
Contam Cmnt
Contam Conf
Alteration
Alteration Type
Alteration Cmnt
Alteration Conf
Charge Hist
Maturity
Maturity Cmnt
Maturity Conf
Fluid Class
Fluid Class Cmnt
Fluid Class Conf
Hist data src
Hist entry date

PVT-Ref

Author
Year
Title
Journal
Doc#
Source
DOI

Any

GOR PVT
Oil dens
Oil dens pSat
Oil dens pReserv
FVF pSat
FVF pReserv
Gas Grav

Thermal restoration of the RCI oil samples

Quality check of the RCI oil samples

New samples

Single Stage Separation. Composition analyses of oil and gas, density, molecular weight

Approval of samples

No

Yes

CME at reservoir temperature

Four Stage Separator test

Viscosity

Differential Liberation

Calculation and reporting

Approval of the report

Not approved

Approved

Final report

IGI · INTEGRATED GEOCHEMICAL INTERPRETATION

Figure 3: *A detailed record of the properties groups associated with PVT test conducted in a PVT laboratory. Also shown are PVT-relevant properties in both the Fluid-Interp and the interpretation-related Any property groups. PVT reference source information is recorded in the PVT-Ref property group.*