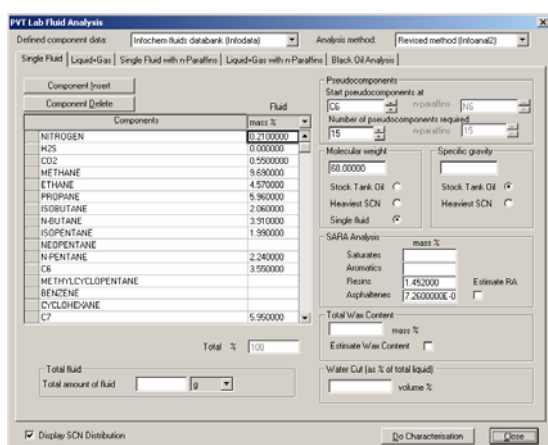


Reservoir Fluid Characterisation

Introduction

Modelling phase behaviour of reservoir fluids usually requires a knowledge of the physical properties of the components that make up that fluid. Current separation techniques cannot distinguish between the many components found in the C6+ fraction of a crude oil. Even if the distinction could be made the properties for the C20+ components would not be known accurately. This problem is resolved by creating an approximate characterisation of the heavier components from a combination of experimental measurements and mathematical methods.

Experimental information



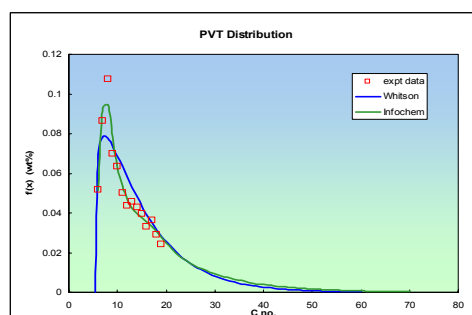
Conventionally, the experimental data is expressed in terms of the low molecular weight discrete compounds plus a series of single carbon number (SCN) cuts terminating with a plus fraction. The data may be provided as a total fluid analysis or as a separator gas and liquid, with different compositions, which are recombined at a given separator GOR. Multiflash also allows for a separate n-paraffin analysis, sometimes measured for use in wax studies.

Additional information that can be taken into account are the water cut, the wax content and the SARA (Saturates, Aromatics, Resin, Asphaltene) analysis.

Fitting a distribution function

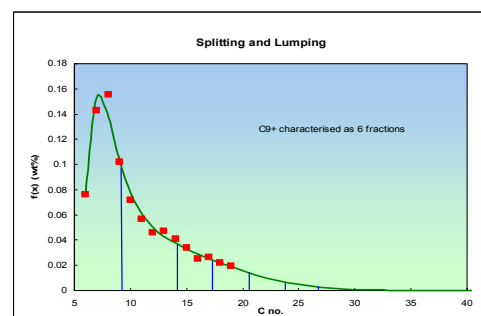
The SCN weight fractions in the liquid, including the plus fraction, are correlated against carbon number using a distribution function. Multiflash fits the distribution with either of two functions, one based on a modified Whitson Gamma dis-

tribution and the other derived from an Infochem proprietary method. The Infochem approach is more flexible and can accurately reproduce SCN distributions that do not follow a standard exponential decay.



Splitting and Lumping the Plus Fraction

Starting from any chosen SCN the remaining plus fraction can be grouped into a specified number of pseudo components. Each pseudo component will be allocated a name and an average molecular weight from which the other physical properties of the cut will be derived. This process will take into account optional information, such as molecular weight or specific gravity of the total fluid or the Stock Tank Oil (STO).



If the experimental composition is only reported to low SCN, i.e. C6+, the distribution function can be extended to higher SCN to obtain the more detailed heavy end analysis needed for certain calculations. The choice of starting SCN and number of pseudo components has to be chosen to achieve a balance between the most accurate representation of the fluid for the purpose in question and the required speed and robustness.

Black Oils

In some circumstances you may have very limited compositional data for a fluid. Either this may not have been measured or the data may have been generated from other applications such as reservoir simulations. It may be that this limited data has to be converted to a more detailed compositional analysis in order to investigate other problems. The Multiflash Black Oil Analysis can operate from the minimum input data of Gas gravity (relative to air), Stock Tank Oil specific gravity (relative to water) and Solution GOR. Additional data that may be available are the Watson K factor and a Gas Analysis and these may be entered as optional input. If a gas analysis is available this too may be entered. The characterisation proceeds as for any other PVT Analysis data.

Properties of Pseudo components

The physical properties of the each pseudo components are calculated from the assigned molecular weight. In practice every pseudo component will be a mixture of several hydrocarbon compounds of different types. The properties of different component types, which may vary from paraffins to naphthenes and aromatics, may well be different even if they have the same carbon number. If sufficient compositional data, such as a PNA distribution, are available it is possible to calculate the physical properties for each type from different correlations and then combine them to define the whole pseudo component. Often, however, the differences are ignored and the properties of the whole pseudo component described by one correlation for each property. In Multiflash the hydrocarbon compound types that can be identified are Normal ("composite"), n-paraffins, non n-paraffin, resin and asphaltene. The correlations used for the thermodynamic properties are largely those recommended by Riazi and Al-Sahhaf. There are three choices of model for calculating viscosity and one for thermal conductivity. Certain properties can be varied to reproduce known values for the fluid, *see Matching below*

To superimpose specific property values for a cut the pseudo component name and basic properties can be entered directly to the petroleum fraction correlation routines.

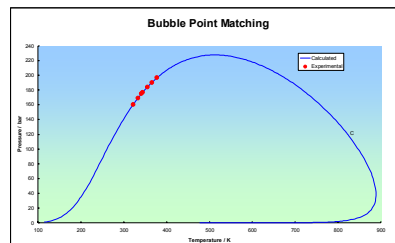
Matching Fluid Properties

Sometimes the properties assigned to the pseudo components will not lead to agreement with a known or measured value for a property of the total fluid. However, it is possible to adjust a property of the individual pseudo components in order to modify a property of the overall mixture.

Dew and Bubble Points

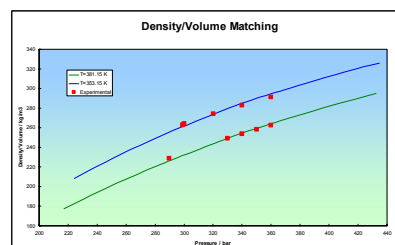
Either single or multiple dew and bubble points can be matched. The pseudo component parameters that are adjusted will depend on the equation of state model being used. For standard RKS the acentric factor is adjusted; for more complex variants, where the vapour pressure of pure components

in the mixture is matched, then the vapour pressures of the pseudo components is adjusted using internal model parameters. The experimental data are compared to the calculated values using the adjusted properties, both numerically and graphically. Multiflash also allows for simultaneous matching of the GOR (Gas/Oil ratio) and the saturation line.



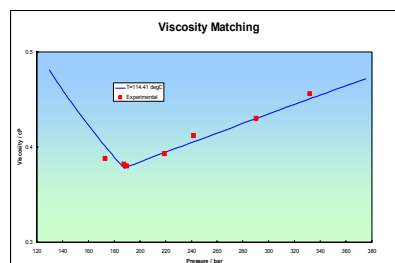
Density/Volume

The density or volume of the total fluid may be matched by adjusting the coefficients for the Peneloux volume shift parameter.



Liquid Viscosity

The liquid viscosity of an oil can be matched by varying the reference viscosity of the pseudo components. This procedure cannot be used for other phases.



Outstanding issues

There are many issues that need to be addressed to further improve PVT characterisation. Some Infochem plan to investigate are:

- Developing common characterisation for multiple fluids so that different fluid streams may be blended in a robust and efficient manner
- De-lumping and re-characterisation of third party characterised fluids

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