

PVT Properties Program

Summary

Weaknesses found in many plans and designs are an inadequate data base of fluid properties, and the use of generalized correlations with accuracies of plus or minus 15-30 percent. Data collection is an important step toward the optimization of both existing field operations and the development of correct future plans and designs.

The EnSys Yocum PVT Properties Program derives accurate analytical equations and associated regression coefficients for reservoir fluids based on laboratory assays of reservoir samples.

A data bank of 50 distinct reservoir fluids has been developed for the simulation of specific fields and the estimation of fluid properties for other fields where limited reservoir data may be available.

- ! In order to establish the requisite pressure/volume/temperature relationships for gas/oil ratio (GOR), liquid and gas densities, mixture density, and liquid viscosity, the tying of fluid properties to actual field data serves as a more accurate method than general correlation. These correlations may also incorporate reservoir depth or a parameter where there is a significant variation of properties with depth.
- ! In early field development or when prospects are under consideration, data availability is at a minimum. In these situations, utilization of the extensive data bank developed by **EnSys-Yocum's PVT Properties Program** becomes invaluable in establishing sound plans, and determining realistic capital and financial requirements.

- ! The fluid properties relationships have been expressed in analytical form with coefficients stored in the data bank.
- ! These coefficients are in the required form necessary to interface directly with other EnSys Yocum models.

A recommended answer to the data acquisition problem for a new reservoir is to perform the best simulations in the early stages by utilizing the Data Banks. Then, as increments come onstream, a careful data collection program may be implemented for all phases so that future field development and planning can be optimized in greater detail.

Calculational System

The calculational procedure permits the user to digitize crude oil assay reports, either in Metric or English units. Using tabulated fluid property values vs. pressure and temperature, the program calculates correlation equation coefficients via a least squares regression analysis technique. The results of either differential or flash expansion laboratory test results may be input.

If there is a variation in physical properties with depth, the liquid density, gas density and gas to oil ratio are specified at standard conditions and at a reference subsea reservoir depth. Generally, the correlated property value is expressed as a function of pressure at a high and low temperature. This enables the main program to obtain property values for a specific pressure and then, by interpolation, the exact value at the flow temperature. Ideally, test results at high and low temperatures which span the temperature range of interest should be available. If variation of the properties with depth occurs, the subsea reservoir depth is input as an additional correlation variable.

EnSys-Yocum MULTIPHASE FLOW SIMULATION

Flash Expansion of Reservoir Fluid

FIELD: Example		WELL: MN-41	
Temperature	EF	135	220
Charge			
Bubble point pressure, Pb	psia	4130	4513
Total volume of charge at Pb, Vb	cm ³	110.877	111.346
Density of total gas evolved at S.C.	g/liter	0.9769	1.0460
Volume of total gas evolved at S.C.	cm ³	15076.40	14768.37
Weight of total gas evolved	grams	14.7281	15.4477
Density of residual oil at S.C.	g/cm ³	0.8596	0.8702
Volume of residual oil at S.C.	cm ³	70.9144	63.3292
Weight of residual oil	grams	60.9580	55.1091
Total weight of charge	grams	75.6861	70.5568
Density of reservoir fluid at Pb	g/cm ³	0.6826	0.6337
Average Compressibility Factor			
of undersaturated reservoir fluid over pressure range 6031 psia to bubble point			
	psi ⁻¹	11.83x10 ⁻⁶	16.17x10 ⁻⁶
Average Thermal Expansion Factor			
of undersaturated reservoir fluid at 6031 psia and over temperature range of 75.0/80.5 to 135/220EF			
	EF ⁻¹	5.69x10 ⁻⁴	5.58x10 ⁻⁴
Gas/residual Oil Ratio at S.c.			
	ft ³ /bbl	1193.50	1309.50

Flash Expansion at 135°F

Pres- sure psia	Relative To- tal Volume	Formation Vol- ume Factor total					
P	Vt	Bt					
6031	0.9791	105284					
5531	0.9840	1.5360					
5027	0.9893	1.5443					
4625	0.9937	1.5511					
4525	0.9949	1.5531					
4425	0.9963	1.5552					
4326	0.9976	1.5572	12.68				
4226	0.9988	1.5592	13.81				
4142	1.000	1.5160					
4039	1.0046	1.5681		5.6021	4000	6.8666	1.0052
3998	1.0062	1.5706		5.8623	3800	6.5330	1.0138
3960	1.0078	1.5731		5.9220	3600	6.2099	1.0243
3923	1.0096	1.5760		5.8216	3400	5.8972	1.0370

! Correlations for the following physical properties are produced by Ensys-Yocum *PVT Properties Program*:

- ⌘ Bubble point pressure, as a function of temperature
- ⌘ Mixture density below the bubble point, at low and high temperatures
- ⌘ Liquid density, above and below the bubble point, at low and high temperatures
- ⌘ Gas density below the bubble point, at low and high temperatures.
- ⌘ Liquid viscosity, above and below the bubble point, at low and high temperatures.
- ⌘ Gas to oil ratio below the bubble point, for at least two temperatures.

The physical properties correlation coefficients are output in the order and format required by the models. The *PVT Properties Program* also produces plots and tabulations of assay values vs. calculated values of the fluid properties.

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