

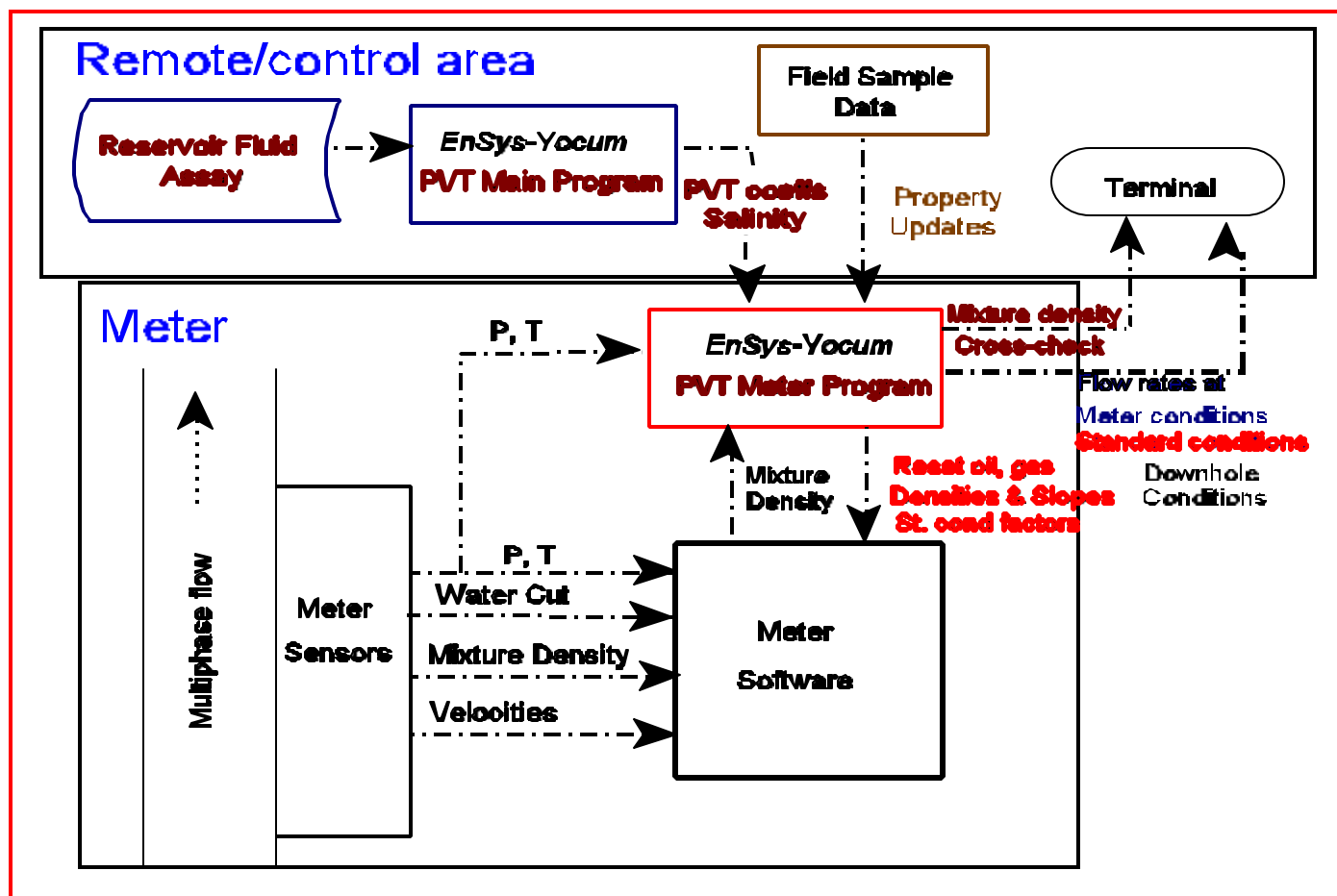
# EnSys-Yocum MULTIPHASE TECHNOLOGY

## *Product Overview: Multiphase and Wet Gas Meter PVT Software*

### Multiphase PVT Multiple Benefits

Integration of EnSys-Yocum PVT software into multiphase and wet gas meters is a low cost route to substantial operating and bottom line benefits:

- g increased accuracy of calculated gas and liquid rates maintained over changing meter conditions
- g flow rate conversion to standard, downhole, separator and other conditions
- g utilizes field samples to update changing produced fluid properties
- g adaptable to multiple well cycling with different assayed properties for each well
- g accounts for presence of dome or injected gas, H<sub>2</sub>S, CO<sub>2</sub>
- g reduces operator intervention/effort
- g raises confidence in multi-phase metering as replacement for test separators



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Combining EnSys-Yocum MPM-PVT software with meter manufacturer hardware and software will provide significant benefits to field operators in terms of improving accuracy of and confidence in on-site multiphase meters. This in turn will promote better field and reservoir management and strengthen the justification for reducing costs through the elimination of test separators.

### **Key Functions Meet Operator's Needs**

The EnSys-Yocum PVT Meter Program uses proprietary fluid characterization techniques to reduce flows to standard conditions. This aspect of the product design permits flows at meter conditions to be converted to oil and gas flow rates corresponding to those used for final delivery and sale. Gas and oil flow rates may also be calculated at any set of alternate conditions. The Program also calculates gas and liquid densities as a function of pressure and temperature, thereby avoiding costly field re-calibration when the meter conditions vary from their original calibration values and maintaining meter accuracy.

### **Unique Basis Assures High Accuracy**

Starting with a laboratory assay representative of the reservoir fluid, the offline EnSys-Yocum PVT Program uses accurate physical properties correlations to calculate equation regression coefficients which represent the laboratory assay results over a wide range of pressure and temperature, to an accuracy of within 1%.

- g One of the major contributions to our success in predicting production facility flow rates, pressure drops and flow characteristics has been our development of a fluid properties PVT program which allows the accurate estimation of state properties at a given pressure and temperature.
- g Data on a large number of reservoir fluids have been correlated to develop a series of

prediction equations. This method of tying the fluid properties to actual field data is more accurate than general correlations for gas to oil ratio, liquid and gas densities, mixture density and liquid viscosity for establishing the requisite PVT relationships.

- g The approach has been proven by the accurate simulation of over 700 worldwide oil and gas systems.

### **Manages Dome/Injected Gas**

The calculation of the mass flow rate establishes the basis for calculating the stock tank barrels and standard cubic feet of gas produced at the standard conditions. This calculation utilizes the metered gas and liquid flow rates and field gas and liquid sample analyses taken at or near the meter. The PVT Meter Program compares the physical properties at meter conditions with those indicated by the metered flow rates (and the field sample results) to the values predicted by the base assay; then utilizes these differences to recalculate the physical properties at standard and alternate conditions. Mixture density measurements are used to confirm the physical properties calculations. There is a program feature to sense the presence of injected or dome gas based on excessive variation from the GOR predicted by the base assay.

- g The criterion used is based on our observations for oil fields worldwide. Variation in the proportion of the gas in the multiphase mixture may derive from variations in reservoir fluid properties (which can be a function of production rates as the reservoir fluid is drawn from different reservoir pay zone depths), by controlled gas injection or by dome gas breakthrough.
  - g If both associated gas and injected/dome gas are present, the gas density slopes will be different for each type of gas. While both respond to P and T variations according to the gas laws and gas compressibility factor variations, the standard condition density of the associated gas increases as heavier gas components are released from the reservoir fluid, while the standard gas density of in-
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jected or dome gas remains constant.

- total flow rate at user-specified downhole P and T conditions

These output values may be interfaced with the manufacturer meter control software to calculate the corresponding gas and liquid flow rates.

## Manages Multiple Wells

**g** In a situation such as an offshore platform where a single multiphase meter is cycled between several wells, the MPM-PVT software can hold data on more than one well assay, should qualities differ appreciably from well to well. Flow measurement accuracy is thus retained as the meter is switched from well to well.

There is provision to report on a CO<sub>2</sub> and H<sub>2</sub>S free basis. The calculations may be performed on a water or water-free basis depending on the split in functions performed between the Meter Calculation Program and the meter manufacturers' software.

## Delivers Key Data

Program outputs include the following:

- at meter P and T
  - gas density
  - liquid density
  - gas density slope versus T
  - gas density slope versus P
  - liquid density slope versus T
  - liquid density slope versus P
  - mass fraction gas
  - mass fraction liquid
- at standard (or alternate) conditions
  - gas density
  - liquid density
  - mass fraction gas
  - mass fraction liquid
- above the bubble point

### OFFLINE FLUID ASSAY PVT ANALYSIS DATA REQUIREMENTS

The following describes the PVT assay data required for us to set up the initial, embedded PVT coefficients. Note the following constitutes the required data needed for us to avoid using estimation.

A typical oil company PVT analysis consists of the following. The viscosity data under item (d) may be omitted if not available:

- (a) Gas to residual oil ratio, density of residual oil and density of total gas evolved, all at standard conditions.
- (b) The bubble point pressure as a function of temperature.
- (c) Mixture density below the bubble point at specified high and low temperatures as a function of flash expansion pressure, which may be expressed as relative total volume. For a differential expansion, provide the gas expansion factor and relative gas volume at standard conditions.
- (d) Liquid viscosity above and below the bubble point at specified high and low temperatures as a function of pressure for flash and differential expansions.
- (e) Liquid density above and below the bubble point at specified high and low temperatures as a function of pressure for flash and differential expansions.
- (f) Gas to oil ratio based on standard residual oil for at least two specified temperatures and as a function of pressure for the differential expansion below the bubble point.
- (g) Gas density at specified high and low temperatures as a function of pressure for the differential expansion below the bubble point.

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## Designed for Speed and Flexibility

The PVT Meter Program is available in C++ and occupies 70K to allow easy integration with meter DAC software. The language statements are coded to minimize execution time.

## Wet Gas PVT Intelligent Metering

EnSys-Yocum Wet Gas PVT software is a variant of the MPM-PVT system with similar benefits:

- g high accuracy of gas and liquid flow rates maintained over changing meter conditions
- g flow rates conversion to standard, separator, downhole and alternate conditions
- g optional properties updating from field samples
- g fluid data as mole fraction composition or full laboratory assay of properties at multiple pressures and temperatures
- g optional integration of densitometer for max-

imum accuracy and management of condensate/water cut variation

Comparisons with the actual field test measurements over a two-fold range of gas condensate flow rates showed an absolute error—without in-line

## Field Tests Show Accuracy Benefit

densitometer—of below 3% for the gas and 7% for the liquid condensate flow rates as measured against separator tests at close to standard conditions. Incorporating a densitometer will further increase these accuracies and improve management of streams with variable water/condensate cuts.

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