Why Do We Need Samples?

1. **To establish the "type" of condensate, and relative richness and potential liquid yields.**

2. **To determine PVT properties and compositional variation of reservoir fluids during depletion.**

3. **To determine the insitu reservoir fluid compositions for estimating initial fluids in place (in terms of sales gas, condensate, and individual component products).**

   To help define the compositional gradient needed to determine (estimate) initial fluids in place.

   Recoverable reserves (expressed as a percentage of initial fluids in place) can vary with the average in-place fluid composition, even though recoverable reserves expressed as volumes may be more-or-less unaffected.

What Is a "Representative" Sample?

Two important engineering definitions should be used for defining "representative" samples.

1. ***Reservoir Representative*** **- any uncontaminated produced wellstream sample from a well in the reservoir.**

   Potentially, more than 90% of all gas condensate samples can be considered reservoir representative and used to characterize the PVT properties of the entire reservoir fluid system.

   However, the main requirement for a fluid sample to be reservoir representative is that accurate PVT data be measured.

   All available samples that have been found to be reservoir representative should be used, simultaneously, to develop the EOS fluid characterization of a reservoir fluid system.

2. *Insitu Representative* - a produced wellstream sample that is representative of the insitu composition at a specific depth (or depth interval) in the reservoir.

The main requirement for an insitu representative fluid, if one can be obtained, is that the composition be measured accurately.

Insitu representative samples are often difficult to obtain. Therefore, interpolation and extrapolation of such samples to define initial fluids in place will always be prone to error.

Usually at least two insitu-representative samples are needed to accurately define initial fluids in place.

How Do We Obtain Samples?

1. **Separator samples are almost always used for gas condensate wells. In some cases (highly undersaturated reservoirs), wellhead samples or bottomhole samples can be used.**

2. **With careful sampling procedures during testing, separator samples can often be both reservoir- and insitu-representative.**

   The key is to produce at rates sufficiently low to minimize pressure drawdown in the wellbore and sufficiently high to ensure that minimum velocity to lift is exceeded (>1.5-3 m/s).

   In almost all situations, test rates meeting the '2' m/s criterion will avoid significant liquid carryover in the separator.

3. Following well cleanup at higher rates, the rate should be lowered and the well produced on a constant choke until the GOR and separator conditions stabilize. Collect at least two sets of separator samples; note the separator conditions and producing GOR during sampling.

Special Sampling Methods

1. *Thorton Wellhead Sampling*. Expensive and excessively elaborate onsite compositional analysis. Not recommended.

2. *Separator Isokinetic Sampling*. May be used for lean gas condensates producing at high rates with significant liquid carryover (or to estimate the liquid carryover).

Results in correction to GOR that is used to recombine standard separator samples. Carryover calculated by material balance using isokinetic and standard separator samples.

Isokinetic sampling should not be necessary for a well-designed sampling program at "low" rates determined by the minimum lift velocity constraint.

3. *Wellhead Isokinetic Sampling*. Developed and used extensively as a commercial service in 1940s and 1950s, together with on-site separator and PVT mini-lab. Current renewed interest in method. Why?

4. *Equilibrium Contact Mixing*. Laboratory procedure for reconstructing accurate in-situ reservoir fluids (gas and oil). Works best for saturated reservoirs. Can use non-insitu representative separator and/or bottomhole samples.

Simple and very accurate when both reservoir oil and reservoir gas samples are available. Also works extremely well for oil well samples produced during gas coning.

Has applications, though somewhat less accurate, for reservoirs with compositional gradients.

Fluid Composition and C_{7+} Properties

1. **Standard GC analysis used for separator gas and separator oil.**

2. **Recommend at least one extended TBP and companion simulated distillation (SIMDIS) analysis for every reservoir. Can develop C_{7+} molar distribution and properties from the one TBP analysis.**

3. **Check effect of (a) erroneous C_{7+} molecular weight and (b) recombination GOR on recombined wellstream composition. These are two primary sources of composition error.**

4. **Use Hoffman Kp-F plot (with Standing's low-pressure K-value correlation) to identify problem with separator samples.**