

PhazeComp

PhazeComp is Zick Technologies' new program for compositional phase behavior computations using an equation of state (EOS). It acts as a virtual PVT (pressure-volume-temperature) laboratory and as a vehicle for tuning EOS fluid characterizations. It can simulate practically any single-cell PVT experiment one can imagine (and many multi-cell experiments as well). It will accept, as input, virtually any data that can be measured in such an experiment. It will then adjust (through non-linear, user-weighted, least-squares regression) any user-selected combination of EOS parameters to optimize the predictions of the experimental data.

PhazeComp will perform all of the calculations expected of a petroleum engineering PVT program, including the simulation of all standard PVT experiments, the prediction of gravity-induced compositional gradients, and the generation of black oil PVT tables. It will use any of the industry standard cubic equations of state and will easily interface with other industry standard software, such as reservoir simulators. These capabilities are not unusual, but PhazeComp also has many *unique* features, which include:

- PhazeComp acts as a virtual PVT laboratory. All calculations (including PVT experiments, flash and saturation point calculations, fluid mixing, etc.) are performed in a precise, user-specified order. The temperatures, pressures, and compositions generated in one calculation can be saved, manipulated, and then used in subsequent calculations.
- Nonstandard PVT experiments can easily be defined. At each stage of an experiment, the temperature, pressure and composition can be altered before equilibration. After equilibration (which is achieved through a flash or saturation point calculation), some or all of either equilibrium phase can be removed. Any number of properties from a list of hundreds (including bulk, compositional, intrinsic, and extrinsic), from before or after fluid removal, can be input as experimental data and/or requested as output. Any set of units can be specified for any of the properties.
- Minimum miscibility pressures and solvent enrichment levels (MMPs and MMEs) can be calculated by a thermodynamically rigorous, multi-cell, multi-contact algorithm. This proprietary algorithm calculates the correct MMP or MME, regardless of mechanism (condensing, vaporizing, or condensing/vaporizing).
- Any or all equilibrium calculations can be tested for the presence of three-phase or multiple two-phase solutions. When characterizing fluids for reservoir simulation, it is highly desirable to detect and avoid the possibility of such solutions, since they usually lead to severe stability and convergence problems.
- Multiple fluid characterizations can be used (and even tuned) simultaneously. Measured compositions may have their own characterizations (with single carbon-number components up to C7+, C10+, or C30+, for example), while the desired fluid model will usually be characterized with *pseudocomponents*. Each characterization can be based upon a parent characterization, so it can be updated automatically if the parent is modified. PhazeComp will allow each fluid to be input in its native characterization and automatically converted to whichever characterization is used for the phase behavior computations.

- Component properties can be initialized manually, with library values, and/or through accepted correlations. Acentric factors and volume shift factors can be calculated automatically from component boiling points and specific gravities, respectively (or vice versa).
- Any number of fluid samples can be handled simultaneously. Samples can be defined (by name) in a variety of different ways. Fluids can be mixed together or split apart to form new fluids. Fluids can also be produced by one PVT calculation or experiment and then used in another.
- Fluid components can be split or pseudoized automatically, as needed, according to user-specified rules. A four-parameter Gamma distribution model is available for component splitting. The Gamma parameters can be unique to each fluid, or shared among different fluids.
- Any number of named *variables* can be defined by the user and adjusted (within user-specified bounds) by regression. Each variable can be used to modify (through multiplication, division, addition, subtraction, or replacement) any number of EOS parameters, viscosity parameters, Gamma parameters, temperatures, pressures, or fluid compositions. Each parameter, in turn, can be modified by any number of variables. This gives PhazeComp unparalleled power and flexibility in tuning EOS fluid characterizations.
- Problem size is limited only by available computer memory. PhazeComp does not restrict the number of characterizations, components, fluids, experiments, variables, or anything else.
- PhazeComp's user interface is any combination of text editors and spreadsheet programs. PhazeComp's free-format, text-only input files can easily be built or edited by these more familiar programs. The structured, text-only output can easily be copied or exported to these other programs for further manipulation, plotting, and reporting purposes. PhazeComp's input files consist of user-controlled sequences of commands and data tables, all with a forgiving and easy-to-remember vocabulary and syntax. Input files can *include* other input files, allowing a structured hierarchy of commands and data. Tables (for characterizations and PVT experiments) can be arranged in any order and even split into multiple sections. They can usually be copied directly from an electronic version of a lab report, with only the headings to be replaced by the appropriate keywords. Experience has shown that there is no quicker or more powerful method of building or editing a complicated sequence of instructions for a PVT program.
- PhazeComp performs all EOS calculations to the limits of machine precision. No other PVT program can boast such accuracy (especially near critical points). PhazeComp will take on all challengers in terms of speed and robustness as well.

PhazeComp is the culmination of more than 20 years of experience in writing EOS and PVT software, which began with the writing of EOSPHASE, an in-house PVT program for ARCO Oil and Gas Company. Even though ARCO no longer exists, EOSPHASE is still in use within the companies that acquired ARCO's assets, and it still compares favorably with other PVT programs of today. Its considerable capabilities are far exceeded by those of PhazeComp, however. Zick Technologies is confident that, from now on, the program of choice for the industry's true PVT experts will be PhazeComp.