CLAIMS

What is claimed is:

1. An apparatus for measuring the density and viscosity~~thermodynamic properties~~ of reservoir fluids, comprising:

a ~~modular~~ sensor assembly, the sensor assembly comprising: a cell body having a sample chamber for receiving a sample of single phase or coexisting two-phase fluid, the sample chamber having therein a piston movable to adjust pressure in the sample chamber; a thermal management system to control temperature in the sample chamber; and a pressure and temperature sensor; and

a density-viscosity sensor located in-situ in the cell body to measure the density and viscosity of the sample in the sample chamber as a function of pressure and temperature.

2. The apparatus as recited in claim 1, wherein the ~~modular~~ sensor assembly further comprises an optic sensor positioned to measure parameters of the sample while in the sample chamber using optical spectroscopic and scattering techniques.

~~3. The apparatus as recited in claim 1, wherein the modular sensor assembly further comprises a piston movable to adjust pressure in the sample chamber.~~

~~4. The apparatus as recited in claim 1, wherein the modular sensor assembly further comprises a thermal management system to control temperature in the sample chamber.~~

~~5. The apparatus as recited in claim 1, wherein the modular sensor assembly further comprises a pressure and temperature sensor.~~

~~6~~3. The apparatus as recited in claim 1, wherein the ~~modular~~ sensor assembly further comprises an agitation mechanism to agitate the sample in the sample chamber.

~~7~~4. The apparatus as recited in claim ~~6~~3, wherein the agitation mechanism comprises an ultrasonic transducer.

85. The apparatus as recited in claim 1, wherein the ~~modular~~ sensor assembly further comprises an automated control to control introduction of the sample into the sample chamber and to control analysis of the sample via the density-viscosity sensor.

96. The apparatus as recited in claim 2, wherein the parameters of the sample measured by the optic sensor include bubble point, dew point, and gas-liquid measurements.

107. The apparatus as recited in claim 1, wherein the cell body geometry is adjustable to different configurations for facilitating the study of different types of fluids.

~~11. The apparatus as recited in claim 1, wherein sensors of a plurality of different sensors are interchangeable in the modular sensor assembly.~~

128. A method of measuring the density and viscosity~~thermodynamic properties~~ of a reservoir ~~fluids~~fluid sample, comprising:

assembling a ~~modular~~ sensor assembly, the sensor assembly comprising a cell body having therein a sample chamber~~to evaluate a sample of a hydrocarbon-containing fluid~~;

charging the~~a~~ sample chamber ~~within a cell body of the modular sensor assembly~~ with the fluid sample;

adjusting the temperature and the pressure of the fluid sample within the sample chamber, wherein the temperature is adjusted with a thermal management system surrounding the cell body, and the pressure is adjusted by a piston in the sample chamber; and

utilizing a single sensor located in-situ in the cell body to determine both density and viscosity of the sample while in the sample chamber.

139. The method as recited in claim ~~12~~8, further comprising using an optic sensor to measure parameters of the sample while in the sample chamber.

~~14. The method as recited in claim 12, further comprising adjusting the pressure of the sample in the sample chamber with a piston.~~

15. The method as recited in claim 12, further comprising adjusting the temperature of the sample in the sample chamber with a thermal management system surrounding the cell body.

16. The method as recited in claim 128, further comprising automatically controlling the charging, adjusting, and utilizing steps with a processor-based controller.

17. A method of measuring the density and viscositythermodynamic properties of reservoir fluids, comprising:

providing a portable, modular sensor assembly at a wellsite;

charging a sample chamber in a cell body of the portable, modular sensor assembly with a fluid sample from a subterranean reservoir;

pressurizing the fluid sample inwithin the sample chambercell body by compressing the fluid sample with a pistonwhile in the sample chambercell body;

increasing the temperature of the fluid sample with a thermal management system positioned as an integral part of the portable, modular sensor assembly;

agitating the fluid sample while in the sample chambercell body to recombine fluid from multiple phases into a single phase; and

utilizing sensors located in-situ inexposed to an inner sample chamber of the cell body to measure the density and viscositydesired properties of the fluid sample.

18. The method as recited in claim 1711, further comprising utilizing a processor-based control system to automate the charging, pressurizing, increasing, agitating, and utilizing steps.

19. The method as recited in claim 1711, wherein utilizing sensors comprises utilizing a single density-viscosity sensor.

20. The method as recited in claim 1711, wherein utilizing sensors comprises utilizing a plurality of density-viscosity sensors.

21. The method as recited in claim 17, wherein utilizing sensors comprises utilizing an optic sensor.