

ENGINEERING - LIST OF TESTS

GE03/08

#	Equipment Name
1	Thermogravimetric Analyzer (TGA); Model: TGA Q50 - per sample
2	Pyrolizer with GC-MS; Model: CDS pyroprobe 5200- per sample
3	UV-Visible Spectrophotometer (UV-Vis); Model: LAMBDA 25- per sample
4	pH Conductivity Meter; Model: Thermo Orion 4 Star - per sample
5	Potentiostat; Model: reference 3000 - per sample
6	Low Level Sulfur Analyzer (LLSA); Model: Multitek - per sample
7	Fuel Reformulyzer (PIONA); Model: Reformulyzer M3 - per sample
8	Densometer; Model: DDM2911 - per sample
9	Differential Scanning Calorimeter (DSC); Model: 204 F1 phoenix - per sample
10	Determination of Oxygenates in Gasoline (GASOHOL); Model: Varian 450 GC - per sample
11	Gel Permeation Chromatography System - per sample
12	Crude Oil Fractional Distillation System; Model: CODS Semi-Automatic Crude Oil Distillation System - per sample
13	Simulated Distillation (Sim Dist); Model: 7890A - per sample
14	Automatic Petroleum Refractometer; Model: K27550 - per sample
15	Elemental Analyzer; Model: Vario Macro cube Analyzer - per sample
16	Water Determination- Karl Fischer; Model: 851 Titrando 15 - per sample
17	Gas Chromatography Mass spectrometer (GC-MS); Model: 5975 MSD - per sample
18	Thermogravimetric Analyzer (TGA) Model: METTLER TOLEDO TGA 2 - per sample
19	Rheometer; Model: Anton Paar MCR 92 - per sample
20	Automatic Asphaltene analyzer; Model: APD600 - per sample

GE01/07

Morphology & Topology Analyses

#	Equipment Name	Type of Analysis
1	Field Emission Scanning Electron Microscope (FE-SEM)	Imaging of microstructure for bulk solid samples, powder, and thin films up to five level of magnification.
		Elemental composition of solid and powder sample (EDX three points ID) for one level of magnification.
		Elemental composition of solid and powder samples (EDX mapping) for one level of magnification.
		Scanning of crystalline structures using electron backscattered diffraction (EBSD) for one level of magnification.
2	Atomic Force Microscope (AFM)	Topography of microstructure for bulk solid samples, powder, and thin films (Roughness of surface).
3	Optical Microscope	Imaging of microstructure for bulk solid samples up to 50x
		Particles and Grain size measurement characterization for a measured sample.
4	3D Optical Microscope (Profilometer)	Imaging a flat solid sample using 10x interferometer, 20x and 50x confocal lenses.
5	Stereo Microscope	Imaging a bulk solid sample up to 2x.

Crystallography

#	Equipment Name	Type of Analysis
1	High-Resolution X-Ray Diffractometer (XRD)	Scanning bulk solid samples, powder and thin films using BB method or PB method.
		Particle size of powder sample using SAXS or USAXS.

Mechanical Testing		
#	Equipment Name	Type of Analysis
1	Universal testing machine (UTM)	At room temperature: Tensile strength test or Compressive strength test
		At one specific controlled temperature using furnace: Tensile strength test or Compressive strength test.
		*Using liquid nitrogen.
2	Rheometer	Rheological testing at one specific controlled temperature: <ul style="list-style-type: none"> ▪ Flow sweep test (viscosity as a function of shear rate). ▪ Strain sweep test. ▪ Stress relaxation test. ▪ Creep recovery test. ▪ Small amplitude. oscillatory shear test (SAOS). ▪ Large amplitude oscillatory shear test (LAOS).
3.	Nano-indenter	Nano-scale mechanical indentation testing.
4.	Hardness tester	Micro-scale mechanical indentation testing.
5.	Tribometer	At one specific controlled temperature: coefficient of friction for up to five specified velocities using the same sample.
Thermal Properties		
#	Equipment Name	Type of Analysis
1	Thermal analyzer (Hot disk method)	At room temperature <ul style="list-style-type: none"> ▪ Thermal conductivity. ▪ Thermal diffusivity. ▪ Specific Heat capacity. *For Liquid and solid samples at one specified controlled temperature.
Chemical Analyses		
#	Equipment Name	Type of Analysis
1	Fourier Transform Infrared Spectrometer (FTIR)	Spectrum for Liquid, powder and solid sample using Attenuated total reflectance (ATR).
2	UV-Vis Spectrophotometer	Spectrum for Liquid sample (Wavelength 320 nm to 800 nm).

3	Static & Dynamic Light Scattering (Zetasizer Nano-ZS)	Determination of size and size distribution of nanoparticles, protein, polymers and emulsions in dispersed forms (0.6 nm to 6 μ m). Zeta potential Zeta potential vs pH (Isoelectric point determination).
4	pH meter	<ul style="list-style-type: none"> ▪ PH. ▪ Conductivity. ▪ TDS.

Elemental Analyses

#	Equipment Name	Type of Analysis
1	Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES)	Elemental composition of aqueous sample based on environmental calibration standard (Fe, K, CA, Na, Mg, Ag, Al, As, Ba, Be, Cd, Co, Cr, Cu, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, Zn, Th, U).
2	Sequential Wavelength Dispersive X-ray Fluorescence (XRF)	Elemental composition of solid sample sing semi-quantitative (SQX) analysis
		Elemental composition of powder and aqueous sample using semi-quantitative (SQX) analysis for single and multi-element.
		Elemental composition of bulk solid sample (Mapping)
3	Ion chromatography (IC)	Elemental composition of aqueous sample (Multi Anion F, Cl, Br, NO ₃ , PO ₄ , SO ₄).

Sample Preparation

#	Equipment Name	Type of Analysis
1	Diamond-saw cutter	Cutting brittle and ductile metals, composites, and plastics.
2	Polisher & Grinder machine	Metallographic sample preparation.
3	Electropolishing Machine	Electrochemical polishing and etching.
4	Cross section polisher	Cross section cutting and polishing.
5	Muffle Furnaces	Heat treatment at ambient air (One run up to 7 hrs.).
6	Vacuum Tube Furnace	Heat treatment at vacuum, argon, or nitrogen gas (one run up to 7 hrs.).

7	Micro plotter	Depositing fluid in a noncontact manner for electronics.
8	Auto fine coater	Coating Unconductive samples for SEM
9	Ball mill machine	Decreasing the size of samples from millimeter size to micro range.
10	Microwave digestion system	Digesting solid samples to liquid form.
11	Pellet press	Making powder samples as a pellet.

GE01/17	
Core Analysis Services	
#	Sample Preparation & Sample Cleaning
1	Drilling and trimming of one plug sample.
2	Core Cleaning using solvents - hot Soxhlet
#	Routine Core Analysis
1	Porosity by Helium porosimeter - ambient conditions
2	Grain density
3	Air Permeability - ambient conditions
4	Air Permeability to air - overburden pressure at one confining pressure
5	Liquid Permeability - overburden pressure at one confining pressure and flow rate
#	Capillary Pressure and Relative Permeability (Centrifuge Method)
1	Initial water (SWI) acquisition by centrifuge - ambient conditions
2	Initial water (SWI) acquisition by centrifuge - maximum 70 °C temperature
3	End point desaturation by centrifuge - ambient conditions
4	End point desaturation by centrifuge - maximum 70 °C temperature
#	Fluid Preparation
1	Preparing simulated formation brine from provided analysis (1 liter)
2	Filtering & de-watering dead crude oil (1 liter)
3	Viscosity & Density of brine - ambient conditions
4	Viscosity & Density of brine - elevated temperature and ambient pressure, per point
5	Viscosity & Density of dead crude oil - ambient conditions
6	Viscosity & Density of dead crude oil - elevated temperature & ambient pressure, per point
#	Interfacial Tension and Contact Angles
1	Contact angle measurement - static
2	Interfacial tension - Spinning drop method, ambient conditions
3	Interfacial tension - Spinning drop method, maximum 1000 psi, 100 °C
4	Interfacial tension - Pendant drop method, ambient conditions

5	Interfacial tension - Pendant drop method, reservoir conditions (single point)
6	Interfacial tension - Du Noy ring, ambient conditions
#	Relative Permeability (USS Displacement)
1	Establishing SWI with oil flood
2	Two phase relative permeability, unsteady state displacement, ambient conditions
3	Two phase relative permeability, unsteady state at reservoir conditions, dead oil
4	Two Phase relative permeability at reservoir conditions, live crude oil.
#	Rock-Mechanics
1	Uniaxial unconfined compressive strength (UCS)
2	Uniaxial static Young's modulus, Poisson's ratio, and compressive strength
3	Triaxial compressive strength
#	Core Flooding (EOR)
1	Thermal Oil Recovery - Hot water flood
2	Thermal Oil Recovery - Steam flood tests
3	Immiscible gas flood Oil Recovery
4	Miscible gas flood Oil Recovery
5	Chemical flood tests (PF/SF/ASP)
6	MMP by Slim tube test, per point
#	Core Imaging
1	CT-Scanning of conventional core
2	CT-Scanning of plug sample
3	Interpretation of CT images

PVT Analysis Services	
#	Sample transfer to lab chamber at reservoir conditions & Fluid sample validation
1	Single phase sample (SSB) Transfer @ Reservoir Conditions (max. 500cc)
2	Recombination of separator fluids to the producing GOR.
3	Measuring opening pressure and saturation pressure at room temperature.
4	Single stage flash to determine solution GOR, formation volume factor and stock tank density.
#	Compositional Analysis
1	SARA analysis of residual liquid sample.
2	Analysis of residual dead oil sample to C ₃₆₊
3	Compositional Analysis - Extended gas analysis to C11+ including Nitrogen and Carbon Dioxide
4	Sim. Dist. of residual dead oil (up to C ₁₂₀₊)
5	Molecular Weight Determination
#	Routine PVT Analysis
1	Bubble point pressure by Constant Mass Expansion (CME) of the reservoir fluid. Including determination of oil density, compressibility above the bubble point, Y-function below the bubble point.
2	Differential Liberation (DLE) study of reservoir fluid to determine the solution GOR, oil/gas formation volume factors, and gas properties
3	Reservoir oil viscosity measurements, made during the depletion study
4	Single stage separator test.
5	Basic PVT analysis package including bubble point pressure by Constant Mass Expansion (CME) of the reservoir fluid. Including determination of oil density, compressibility above the bubble point, Y-function below the bubble point. GC analysis of flashed gas to C ₁₂₊ and stock tank oil to C ₃₆₊ , with mathematically recombined reservoir fluid composition to C ₃₆₊ .
6	Complete PVT analysis package including CME, DLE, reservoir fluid viscosity measurements, Single Stage Separator test, with GOR, and Bo. GC analysis of flashed gas to C ₁₂₊ and stock tank oil to C ₃₆₊ , with mathematically recombined reservoir fluid composition to C ₃₆₊ .
#	Specialized PVT Analysis
1	Solubility Swelling Study - Constant composition expansion (CCE) at reservoir temperature.
2	Measurement of Asphaltene onset conditions including particle size distribution. (Near Infra-Red (NIR) spectrograph)

3	Titration of reservoir fluid with injection gas, determination of asphaltene onset as a function of GOR.
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Polymer Evaluation Services

#	Polymer Evaluation
1	Polymer mother solution preparation, 1 concentration, 800 mL
2	Polymer mother solution dilution
3	Polymer stability/compatibility test, 1 concentration, 1 temperature, 10 days
4	Polymer filter ratio test, 1 concentration, 1 pressure, room temperature, 600mL sample
5	Polymer screen factor test, 1 concentration, 1 temperature
6	Polymer viscosity versus shear rate, 1 concentration, 1 temperature, 10 shear rates
7	Polymer viscosity versus polymer concentration, 1 shear rate, 5 concentrations, 1 temperature
8	Polymer hydration/dissolution test, 1 concentration

GE01/08

#	Equipment Name
1	Atomic Force Microscope (AFM) – (approximate analysis time: 48 hrs.)
2	Optical Microscope - (approximate analysis time: 2 hrs.)
3	Spectrophotometer - (approximate analysis time: 3 hrs.)
4	Spin Coater - (approximate analysis time: 2 hrs.)
5	Muffle Furnace - (approximate analysis time: 7 hrs.)