

Analytical Software & Equipment Survey		
Equipment Description	Performance Characteristics	Special Features
Standard Lab Facilities (38 Labs)		
Balances		
Desiccator Cabinet		
Distilled/Deionized/Ultrapure Water		
Convection Oven		
Drying Ovens		
Electrical Conductivity (EC) Meter		
Fume Hoods		
High-Temperature Furnace		
Oxidation Reduction Potential (ORP) Meter		
pH Meters		
Refrigerators		
Ultrasonic Bath Cleaner		
Analytical Equipment/Facilities		
Air Source Samplers	Apex XC-60	
Arsenic and Selenium Chemicassettes	CEM for As and Se in gas streams	
Ashing Furnace		
Atomic Force Microscope	Used to to quantify the interfacial surfaces of asphalt binder thin films and aggregate, polymer, and fillers such as lime	
Brunauer, Emmett, and Teller (BET) Surface Analyzer		
Coal Self Heating Index Test Rig	TA Instruments Q2000 DSC with autosampler and operating temperatures of -90°C to 400°C. Techniques include glass transitions, "cold" crystallization, phase changes, melting, and crystallization. Determines spontaneous combustion index through measure of oxygen uptake.	

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Differential Scanning Calorimeter	To measure phase transitions of various samples	
Electromagnetic Survey Equipment	To determine extent of coal and power production impact on subsurface environment	
Flexible-Wall Permeameter	To determine permeability of contaminated solid media and ash materials, etc.	
Fluorescence	Perkin Elmer Model LS50B luminescence spectrometer with FL Data Manager software data system for fluorescence analysis	
Fourier-Transform Infrared (FTIR)	Perkin-Elmer Spectrum One and Multiscope for functional group and quantitative analysis	Including microscope, and attenuated total reflectance (ATR)
Gas Analyzer, Testo		
Gas Chromatograph w various detectors	Agilent 5890 Series II GC and Agilent 6890N with ChemStation data system. Can be configured for a variety of applications such as gas, volatiles, and semivolatiles range organic compounds.	Dual split/splitless injection ports and Model 7683B autoinjector; flame ionization, micro-ECD, and thermal conductivity detectors
Gas Chromatograph / Mass Spectrometer	Agilent 6890/5973 with ChemStation data system and NIST spectra library	With a split/splitless injection port and Model 7683 autoinjector for semivolatile range organic compound analysis; volatiles inlet; and Tekmar 3100 purge and trap concentrator with Tekmar Aquatek 70 autosampler for analysis of volatile range organic compounds
Gasification Test Apparatus, Bench-Scale		
Gel Permeation Chromatograph (GPC)		
Gold Sputter Coater		

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High Performance Liquid Chromatography (HPLC) and Gel Permeation Chromatograph (GPC)	(1) Waters 60F pump, 600 controller, 717 autosampler, 2487 UV detector, R401 refractive index detector, and Alltech Model 800 evaporative light scattering detector with Chromperfect Spirit software data system. (2) Waters 60F pump, 600 controller, 717+ autosampler, 2489 UV detector, 2414 refractive index detector, ELS evaporative light scattering detector (3) Waters 60F pump, 600 controller, 717+ autosampler, 2489 UV detector, 2414 refractive index detector, ELS evaporative light scattering detector, Fraction Collector	For a variety of analytical and preparatory-scale HPLC analyses
High-Temperature Thermogravimetric Analysis (TGA)	Phase change analysis of coal and other materials	
Inductively Coupled Plasma/Atomic Emission Spectrometry	Thermo Elemental AtomScan Advantage	For metals and elemental analysis
Ion Chromatograph		For anion and cation analysis in water samples and digests
Magnetic Resonance Imaging		
Mercury Analyzer, Buck Scientific 410		
Mercury Analyzer, Leco AMA254	Mercury in coal analyzer	
Mercury Analyzer, Tekran 2600	Natural gas analyzer mode	Currently set up as CEM; field cartridge capable (Modified Method 30B)
Mercury Analyzer, Tekran 2600	Water analysis mode	Can be used in conjunction with acid digest
Mercury Analyzer, Sorbent Trap	Ohio Lumex RA-915+	
Nuclear Magnetic Resonance	Chemagnetics CMX-100/200 solids NMR spectrometer	With 2.34 Tesla 100 MHz H freq. and 4.7 Tesla 200 MHz freq. magnets

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Pressure Aging Vessels (PAVs)	Laboratory-scale PAVs with variable time, temperature and pressure	
Pyrolysis Equipment	Batch reactor for 5g, 50g, 500g samples, including fluidized sand baths	
Rheometers	Bending beam and dynamic shear rheometers for heating and pyrolysis investigations of crude oils, vacuum residua, and heavy oils	
Respirometer	To assess biological impacts of coal and power production	
Scanning Electron Microscope (SEM)	Microscopic phase analysis for solid samples and sorbents	
Sulfur Analyzers, IR	Continuous emission monitors (CEMs)	
Sulfur Analyzer, Leco	Sulfur in coal analyzer	
Thermogravimetric Analysis (TGA)	Q500IR TGA with autosampler and an operating range of ambient to 1200°C. Measures a material's thermal stability and composition.	
Thermomechanical Analysis (TMA)		
Total Organic Carbon Analyzer		
Ultra-Performance Liquid Chromatograph/ Mass Spectrometer (UPLC/MS)	Waters Acquity UPLC, autosampler, TUV detector, EMD1000 mass spectrometer for a wide variety of scan and SIM mass spectra at low detection limits	
Ultrasonic Spectroscopy	Panametrics Epoch IV pulser/receiver with ScanView Plus software and a variety of heated sample cells for phase change investigations	

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UV-Vis Spectrophotometer	Shimadzu UV1800 with photometric and scan modes	
UV-Visible Flow-Through Spectrometer	Wide range of colorimetric applications to identify organics and inorganic associated with consequences coal power production	
Vapor Pressure Osmometer (VPO)	Knauer VPO for molecular weight determination	
X-Ray Defraction (XRD)	Phase analysis for solid samples and sorbents	
Bench and Pilot Equipment		
Biomass/Coal Steam Pyrolysis Test Unit	Up to 200 pph coal, biomass or mixtures	Complete analytical support for gas analysis
Bubbling Fluid Bed Coal Upgrading Reactor, Bench-Scale	Batch reactor, flexible feed, flexible exposure media and temperature	
Catalyst Manufacturing and Testing Facilities	10 g to 5 kg capabilities	
Coal Ash Disposal/Re-use	Pelletizer, liner compatibility testing, batch ash extruder	
Coal Upgrading Pilot Plant	100 tpd	
Cold Flow Reactor Testing Platform, pilot scale	Pre-deployment reactor testing and design confirmation rig	
Combustion Test Facility	250,000 Btu/h test facility designed to mimic a utility boiler. Facility is used for testing of feedstocks, emissions control technologies, sorbents	Real-time online gas analysis equipment. Equipped with CEM for mercury. Capable of oxyfuel-firing (weblink)
Continuously Stirred Tank Reactor (CSTR) for FT Testing	Flexible synthesis catalyst testing for BTL, CTL, GTL	
Control Systems Development Laboratory	PC-based operator interface development for diverse and unique processes	
Corrosion Surveillance Test Laboratory		
Fixed-Bed FT Synthesis Reactor	Flexible synthesis catalyst testing for BTL, CTL, GTL	

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Fixed-Bed Sorbent Endurance Testing Rig	Flexible feed gas mixing. Hg, SO ₂ , CO ₂ sorbent analysis. Capable of medium-high temperature (316oC)	For gasification and combustion of flue gas and syngas cleanup
Fluidized-Bed Based Coal Upgrading Reactor	Up to 400 ppph processing capacity (weblink)	Patented technology for removing water, increasing the heating value and removing mercury from low-rank coals
Fluidized-Bed Gasification Test Facility	Up to 50 pph coal, biomass or mixtures	Complete analytical support for gas analysis
Heavy Oil Upgrading Facility	1 bbl and 5 bbl per day	
High-Pressure Containment Chamber	Reactor for diverse testing under controlled isobaric conditions	
Hybrid Sorbent Testing Apparatus (Proprietary)	Multiple feed gas mixing, varying exposure temperatures, fixed or moving bed, multiple pollutant ready, gasification or PC combustion ready	High-temperature capable (1500°C)
Hydrogen Separation Membrane Test Facility		
Materials Testing Laboratory		
Multi-Pollutant Emission Control Facility	Complete lab with conventional sorbents, nano-based sorbents, CO ₂ storage sorbents, gas or water stream applications and multi-pollutant sorbents.	
Oil Analysis Laboratory		
Ozone Generators with Ozone Exposure Rigs	High-concentration ozone generation, flexible feed gas. 100 g batch reactor, flexible feed. Water-based multi-batch reactor system.	Bed temperature profiling, oxidized carbon speciation
Slurry Bubble Column FT Reactor	Flexible synthesis catalyst testing for BTL, CTL, GTL	
Stack Gas Testing System (Method 29)		
WRITE Pilot Coal Upgrading Plant, Mobile Unit	Combustion and gasification integration demo unit for 1 MWth integrated facilities	Mobile for use at various sites
WRITE Pilot Coal Upgrading Plant	Removes 99% moisture and up to 80% volatile metals such as mercury (1 ton/day)	

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Software Description	Performance Characteristics	Special Features
MINEQL+ version 4.5	Chemical equilibrium modeling system (water)	
Surfer	Geostatistical modeling	Contouring and 3D surface mapping
Solid Works	3_D Mechanical Modeling, with integrated Finite Element Analysis software.	CAM compliant, Rapid Prototype Compliant
ASPEN Plus w/Tasc and other codes	Complete Thermo/Fluids Analysis, Specific Package oriented to power industry	Heat exchanger analysis, plant efficiency modeling
WRITE Coal Thermal Model	Complete Thermal model with adjustable input values used for system scaling	
WRICBM-reservoir coal bed methane simulator. Developed in-house	Fully implicit formulation allows modeling of complex reservoir descriptions.	Simulates performance of coal bed reservoirs and coal mines. Applicable to conventional CBM production (by depressurization), enhanced coal bed methane recovery, and sequestration. Multi-component gas description predicts performance of any number of components. Allows coal-sandstone reservoir description.
TCROW-reservoir simulator for recovery of contaminants from aquifers by thermal methods. Developed in-house	Fully implicit formulation allows modeling of complex reservoir descriptions.	Developed to predict recovery of contaminants from underground aquifers by WRI's patented CROW process. Predicts recovery (by displacement) of contaminants by injection of hot water or steam.
TSRS-reservoir simulator for thermal recovery of oil by thermal methods. Developed in-house	Fully implicit formulation allows modeling of complex reservoir descriptions.	Predicts recovery of oil by thermal methods, including in-situ combustion and steam floodings. Also predicts recovery by conventional reservoir pressure depletion and water flooding. Permits multi-component description of gas and oil phase.
UTCOMP-reservoir simulator for oil recovery by CO2 injection. Developed by the University of Texas	Employs an implicit pressure explicit saturation (IMPES) formulation	Predicts oil recovery by miscible displacement of injected CO2.