

ProTechnics Tracer Services

Measured Solutions with Isotope and Chemical Tracers

ProTechnics isotope and chemical tracer services inject uniquely identifiable tracers into specific segments or stages of a stimulation or cementing treatment. Combined with our specialized imaging services, these tracers allow direct measurement of treatment placement for completion diagnostics that enhance production.

For over 20 years, ProTechnics has been an innovator in completion diagnostic services. Our advanced diagnostics build on a long tradition of industry firsts, including the PT-4000 low-pressure injection system, multiple isotope treatments, patented ZeroWash® tracers and a unique family of chemical tracers.

Reliable Tracer Injection

The PT-4000 low-pressure injection system has been used to safely, accurately and reliably perform over 40,000 injection treatments in some of the harshest conditions. Versatile and easily mobilized for service around the world, the PT-4000 system is quick to set up and simple to operate.

Injection system features include:

- Safety – low-pressure work environment
- Accuracy and control – precise injection with low volume peristaltic pumps
- Reliability – simple operation and 100% redundancy for all major mechanical components
- QA/QC
 - Individual isotope reservoirs
 - Field isotope activity assays
 - Real-time monitoring and communications

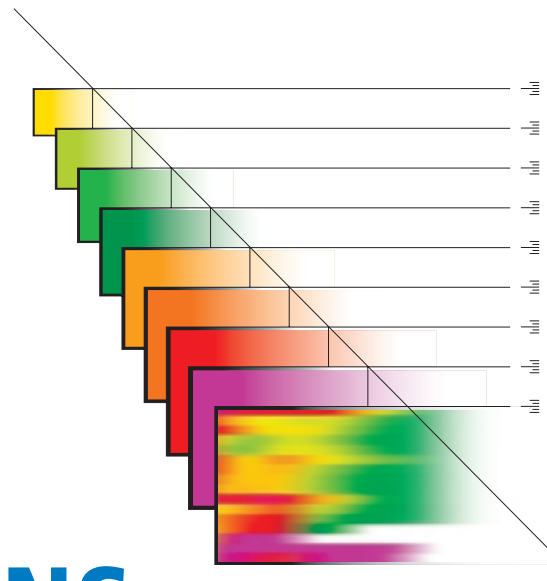
HSE Commitment

ProTechnics is committed to the highest health, safety and environmental standards. Our regulatory, operational and training procedures and guidelines are fully sanctioned and licensed by the Nuclear Regulatory Commission (NRC) and appropriate state authorities. ProTechnics has a safety record that is unsurpassed in the industry.

Regulatory testing and environmental impact studies have approved ZeroWash tracer particles for burial, offshore disposal and injection in Class II disposal wells.

ProTechnics tracer services consist of five service groups:

- SpectraStim™
- SpectraChem™
- SpectraMark®
- SpectraFlood™
- InvasionProfiler™



MEASURED SOLUTIONS

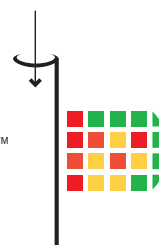
SpectraStim™ Isotope Tracers

SpectraStim tracer services involve precise injection of uniquely identifiable gamma-emitting ZeroWash® tracers into discrete segments of a completion treatment. Applied in single and multiple isotope designs, SpectraStim services have been the backbone of completion diagnostics for over 20 years.

SpectraStim tracers provide advantages in many applications, including:

- Hydraulic fracturing treatments
 - Crosslinked gel fracs
 - Frac packs
 - Water fracs, low concentration (ppg) sand fracs
 - Energized nitrogen or CO₂ foam and assists
- Acid treatments
 - Matrix
 - Fracture

SPECTRASTIM™



- Cementing
 - Primary
 - Squeeze
- Gravel pack treatments
 - Gel pack
 - High-rate water pack
- Mechanical integrity tests
- Conformance control polymer treatments
- Horizontal well completions

SpectraChem™ Chemical Tracers

Improving fracture cleanup and flowback efficiency maximizes effective frac length for an incremental ROI over the life of the well. SpectraChem measurements allow completion engineering teams to design and achieve a more productive frac treatment. Understanding effective versus created frac length is critical to optimizing frac design and enhancing productivity.

The patented SpectraChem family of chemical frac tracers (CFT) provide two powerful diagnostic capabilities:

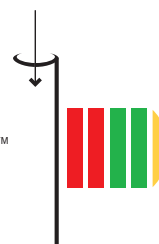
- Measurement and evaluation of frac fluid cleanup and flowback efficiency
- Characterization and assessment of early contribution in multizone wells

As many as 22 different CFTs can be introduced into a completion program. Post-frac flowback samples are collected and analyzed in the laboratory using gas chromatography and mass spectrometry to accurately quantify the presence of the CFTs in parts per billion.

SpectraChem tracer applications include:

- Frac fluid cleanup/flowback mechanisms and efficiency
- Breaker efficiency
- Fracture interference with offset wells
- Relative zonal contribution in multiple stage completions

SPECTRACHEM™



- Flow-through bridge plug assurance
- Smart well completion production assurance

The ProTechnics Early Production Test (EPT) offers a quick wellsite test for determining if:

- Smart well and stage isolation equipment is operating properly
- Multi-stage completions are producing as anticipated

EPT places a proprietary, water-soluble chemical tracer in the completion fluid. This allows a produced water sample to be tested with a disposable lateral flow device that wicks the fluid past a chemically modified "detector."

Invasion Profiler™ Mud Tracers

Invasion Profiler mud tracer services provide geologists, reservoir engineers and petrophysicists with a higher level of confidence and accuracy in core analysis and formation sample results. Determining total mud filtrate invasion values in both coring and downhole formation fluid sample operations provides many advantages.

Coring operations benefit from:

- Accurate in-situ fluid saturation determination for reserve certification
- Determination of F_m brine salinity and accurate R_w
- Determination of fresh-state relative permeability

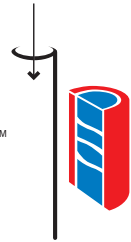
Downhole formation fluid samples benefit from:

- Mud invasion quantification
- Increased confidence in PVT data (viscosity, FVF, bubble point, and composition)
- More reliable reservoir simulation
- Optimized production facilities design

Invasion Profiler tracer services use an environmentally-friendly process to trace both water-based and oil-based mud systems. Tritium is commonly used to trace water-based systems; a proprietary oil-soluble tracer is used in oil-based systems.

Detailed comprehensive summary reports and calibrated fluid saturations enhance data integration and formation evaluation. The InvasionProfiler log allows you to see in-situ reservoir fluids in a graphical log plot format.

INVASIONPROFILER™



SpectraFlood™ Interwell Tracers

Average reservoirs give up 15 to 20% of their oil-in-place under primary recovery. Secondary and tertiary recovery can in many cases wring another 30% or more out of these reservoirs. SpectraFlood interwell tracer services play a vital role in optimizing recovery from EOR projects.

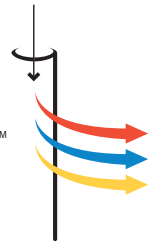
SpectraFlood interwell tracer services are used to:

- Identify reservoir heterogeneity
- Determine sweep efficiency
- Determine directional permeability
- Pinpoint early breakthrough paths
- Obtain parameters for pilot flood design

ProTechnics uses proprietary isotope, chemical and gas phase tracers in conjunction with an engineered black oil simulator-generated tracer design program. Design parameters such as reservoir properties, well spacing and injection patterns are used to determine the optimum type and amount of tracer.

Scheduled samples obtained from surrounding producers are analyzed by our highly-trained chemists with state-of-the-art laboratory procedures and equipment, including gas chromatograph, mass spectrometry and liquid scintillation.

SPECTRAFLOOD™



SpectraMark® Depth Correlation



When depth correlation is critical, be on your mark with SpectraMark services. These isotope markers provide positive, precise depth correlation that enhance safety, increase reliability and reduce costs. Applied as a removable or permanent marker, SpectraMark markers are available in wire, encapsulated and bead forms.

Whether correlating flush joint casing, non-magnetic tubulars or multiple strings, the economical solution provided by SpectraMark radioactive markers can mean the difference between guesswork and reliable correlation.

SpectraMark services provide advantages for a wide range of applications, including:

Collar Marking

- Tubing
- Casing
- Work strings
- Drill pipe
- Flush joint X-line pipe
- X-line pipe

Equipment Marking

- Centralizers
- Cement plugs
- Liner hangers
- Subsea safety valves
- Packers
- PBR and seal assemblies

Depth Correlation

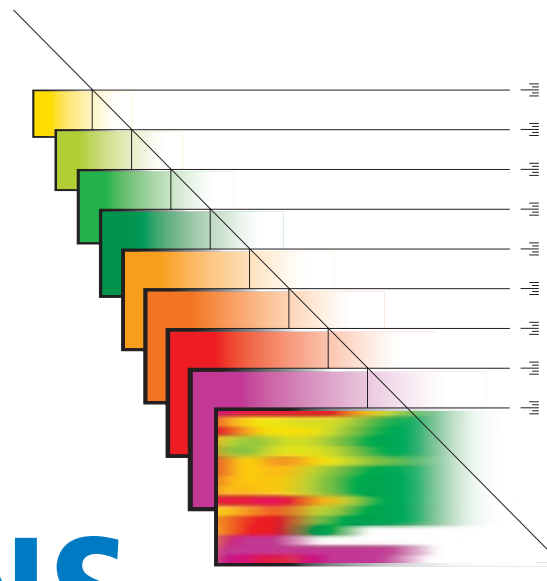
- Whipstocks
- Perforating
- Packer setting

Non-magnetic Tubulars

- Fiberglass casing or tubing
- Low carbon alloys
- Ni, Cr13

Compaction Monitoring

- Multi-year time lapse monitoring



URED SOLUTIONS

ZeroWash® Isotope Tracer Technology



ZeroWash tracers are manufactured using a patented process that prevents the isotope from being washed off the proppant-emulating carrier particle. This process fixes non-water-soluble metals in a ceramic matrix. After the resulting ceramic beads are kiln fired and sieved, they are activated by neutron bombardment in a nuclear reactor.

Because the resulting tracer particles are so effectively formed with no potential for wash off, ZeroWash tracers provide unsurpassed environmental stewardship. They are HSE preferred and U.S. Nuclear Regulatory Commission (NRC) approved for burial, offshore disposal and injection in Class II disposal wells.

ZeroWash tracers, available in three primary isotopes, are produced in two forms:

- ZeroWash ZW – an intermediate strength ceramic particle
- ZeroWash ZWLD – a low-density ceramic particle

SpectraTek™ Services

ProTechnics isotope tracer manufacturing and laboratory services are provided by our SpectraTek Services Division in Albuquerque, New Mexico. The facility's fully-automated "hot cell" and distribution capability ensures high quality

isotope materials to meet our global tracer operation requirements.

Experienced SpectraTek personnel are focused on developing programs to continuously refine calibration accuracy for radiochemistry designs.

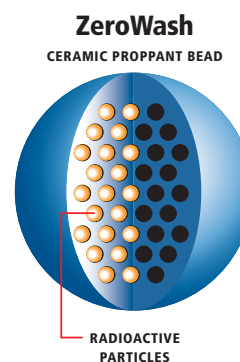
SpectraTek services include:

- Instrument calibration, sales and service
- Leak testing of sealed sources
- License and procedure assistance
- Radiation safety training
- Radiation program consultation

ISOTOPE TABLE

Isotope	Symbol	Form	Half Life Days	Energy Spectrum (million electron volts)	Maximum Permissible Concentration (pCi/mL and pCi/Gr)	Disposal Method
Iridium 192	Ir-192	ZW, ZWLD	74 days	0.311, 0.468, 0.609	10	B, OD, CII
Scandium 46	Sc-46	ZW, ZWLD	83.8 days	0.889, 1.121	10	B, OD, CII
Antimony 124	Sb-124	ZW, ZWLD	60.2 days	0.603, 0.720, 1.691	7	B, CII
Tritium ¹	H ₃ O	Liquid	12.3 years	N / A	1000	N / A
Cobalt 60	Co-60	1/4 in. wire	5.27 years	N / A	N / A	N / A
Cesium 137	Cs	Encapsulated	30.2 years	N / A	N / A	N / A

¹ beta emitter B (Burial) OD (Offshore Disposal) CII (Class II Injection)



TRACER PROPERTIES AND USAGE

Tracer Form	Description	Mesh Size	Specific Gravity	Crush Strength (psi)	Color	Application	Concentration (mCi)
Zero Wash (ZW)	Intermediate strength ceramic bead imbedded with oxide form of the isotope	40/70 16 - 80 mesh available	2.65	> 8,000	Various shades of gray	Designed to emulate particulate materials. Primarily used to trace proppants	.35 to .6 mCi per 1000 gal or 1000 lb
Zero Wash LD (ZWLD)	Low density ceramic bead imbedded with oxide form of the isotope	40/70 30 - 100 mesh available	1.3 - 1.48	1,500 - 2,000	Dark green to brown	Designed to emulate fluid and low density materials. Used to trace pad fluids and acids at matrix rate	.5 to 1 mCi per 1000 gal or 1000 lb
Collar Mark	1/4 in. wire approximately 2 cm long	N / A	N / A	N / A	N / A	Depth control, cement hardware, non-ferrous tubulars, compaction	1 microcurie

ProTechnics Division

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U.S. Locations

Alice, Texas

Anchorage, Alaska

Bakersfield, California

Casper, Wyoming

Duncan, Oklahoma (Stim-Lab)

Farmington, New Mexico

Fort Worth, Texas

Grand Junction, Colorado

Kilgore, Texas

Lafayette, Louisiana

Midland, Texas

Oklahoma City, Oklahoma

Rock Springs, Wyoming

Sydney, Montana

Trinidad, Colorado

Vernal, Utah

International Locations

Calgary, Alberta

Edmonton, Alberta (PROMORE)

Grand Prairie, Alberta

Red Deer, Alberta

Poza Rica de Hidalgo, Mexico

Veracruz, Mexico

Villahermosa, Mexico

Maracaibo, Venezuela

Maturin, Venezuela

Aberdeen, Scotland

Dammam, Saudi Arabia

Abu Dhabi, United Arab Emirates

Hassi Messaoud, Algeria

Luanda, Angola

Malabo, Equatorial Guinea

Jakarta, Indonesia

Beijing, China

Adelaide, Australia

Auckland, New Zealand

For more information, including case histories, technical papers and issues of the ProTechnology newsletter, please visit our website at:

www.corelab.com/protechnics

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