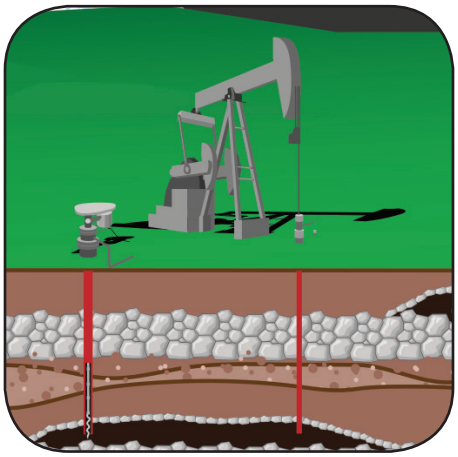
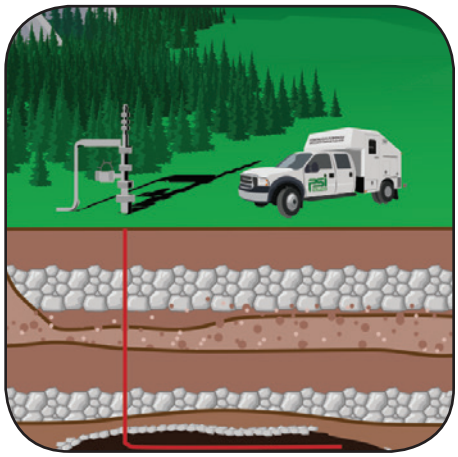
Hardware Selection Guide Conventional Pressure and Temperature

Permanent Downhole Gauge Systems

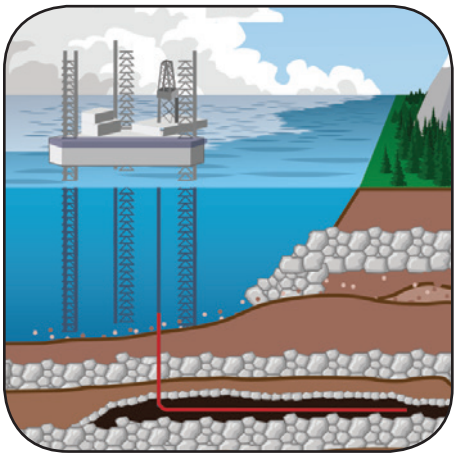
PUMP CONTROL



LAND BASED SYSTEMS



OFFSHORE MARKET



PURPOSE OF PERMANENT GAUGE SYSTEM

- Fluid level monitoring for pump control
- Reservoir presssure control for sand protection
- Production optimization
- Well performance
- Pump performance monitoring
- Reduced workovers

- Reservoir monitoring and drainage efficiency
- Increased production
- Increased ultimate reservoir recovery
- Interference testing
- Transient analysis
- History matching

- Reservoir monitoring and drainage efficiency
- Increased production
- Increased ultimate reservoir recovery
- Interference testing
- Transient analysis
- History matching

RETURN ON EQUIPMENT INVESTMENT IS MEASURED BY

- Minimum acceptable standard is for the permanent downhole gauge run to be as long as the workover cycle of the downhole pump
- The system should be re-deployable
- System must be engineered to withstand downhole forces exerted by pumps

- O&G emphasize system reliability and data quality
- Reservoir pressures are typically medium to high
- Completions are complicated
- Permanent downhole gauge equipment must be engineered for performance

- O&G emphasize system reliability and data quality
- Reservoir pressures are typically medium to high
- Completions are complicated
- Permanent downhole gauge equipment must be engineered for performance

TYPICAL SYSTEM COST

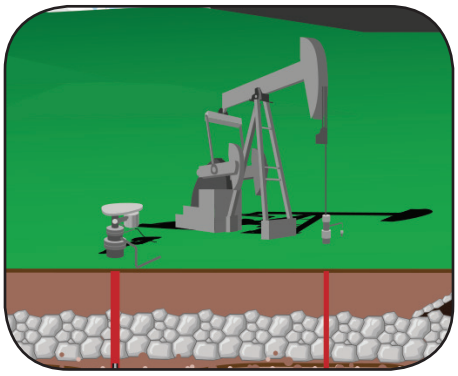
$	$$	$$$

The Future is Real Time™

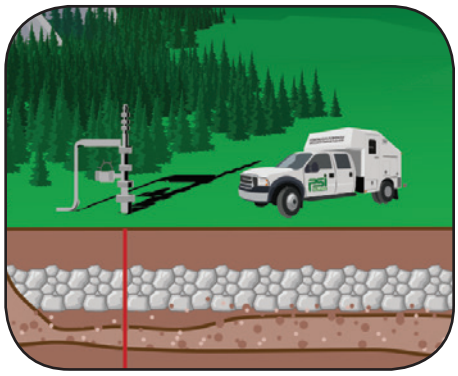
ONLINE GEOPSI.com PermServices.com

Last Revised: 130430

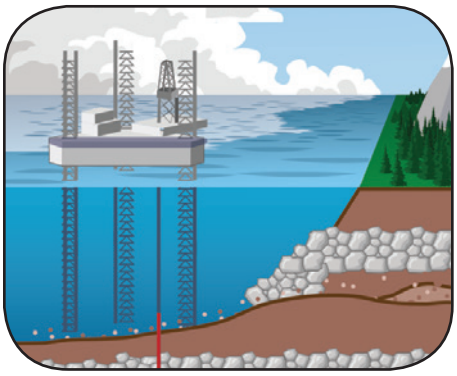
PUMP CONTROL



LAND BASED SYSTEMS



OFFSHORE MARKET



TYPE OF GAUGE

- Dominiated by 4-20 mA equipment. Cost effective and does not require expensive surface interfaces. Gauge data interfaces directly with vfd's, loggers, and plc equipment.
- Typically single or multi digital piezo resistive or quartz gauges. Reservoir temperatures may be higher. Emphasis is on transient analysis.
- Dominated by single or multi quartz gauges. Reservoir pressure and temperatures are often extreme. Pressure accuracy and low drift is of utmost importance.

DETAILS

- Typical data accuracy: 0.5% fs
- Resolution: +/- 0.5 psi
- Drift: Less than 3 psi per year
- Typical data accuracy: > 0.05% fs
- Resolution: +/- 0.005 psi
- Drift: Less than 3 psi per year
- Typical data accuracy: > 0.015% fs
- Resolution: +/- 0.0006 psi
- Drift: Less than 0.02% per year.

GAUGE MANDREL

- Simple & cost effective. Most gauges are set to measure annular pressure.
- Ranging from simple & cost effective to premium internal sensing unibody mandrel. May need to be field pressure testable.
- Premium internal sensing pressure testible unibody mandrels.
- Frequently mandrels require exotic threads.

DOWNHOLE INSTRUMENTATION CABLE

- Bare stainless steel to encapsualted cable for additional shock protection, depending on completion and pump dynamics.
- Bare stainless steel to encapsualted cable for additional shock protection, depending on completion.
- Completions are usually horizontal. Encapsulated cable is required.

CABLE PROTECTORS

- Depending on completion, will range from banding, light duty collar protectors to heavy duty protectors.
- Light duty cable protectors for vertical completions or heavy duty carbon steel protectors for horizontal completions.
- Typically completions are horizontal. Heavy duty carbon steel or stainless steel protectors are utilized.

The Future is Real Time™

ONLINE GEOPSI.com PermServices.com

Last Revised: 130430