Smart Plunger™
by PCS
What they are

- Highly accurate downhole pressure & temperature gauges
- Contained inside a variety of high quality plunger styles
- Utilized in a traveling mode or stationary position
- 750 – 15,000 psi
- 300 °F & higher
- Over 1,200,000 sample points
- 1 sample/ second minimum
- USB or serial interface for easy programming & downloads
- Low power consumption – single AA lithium battery
What they can do

- Skin Damage
- Open Flow Test
- Compression Draw-Down Test
- Draw-Down test
- Multi-Stage Plunger Lift Optimization
- Plunger on Bottom
- Plunger-lift Optimization
- Reservoir Analysis
- Pressure Survey
- IPR 4-Point Test
- Tubing Leaks

Smart Plungers
Advantages

• Record real time pressures & temperatures for cycles covering entire well bore
• Detect tubing holes/ leaks and fluid levels
• Ensure plunger hits bottom
• Eliminates wireline costs – install & retrieve data loggers via plunger lift operation for reservoir studies, 4-point testing, etc.
• Immediate access upon plunger retrieval at well head
• Easily program and download data logger commands and data on location
• Combine TRAVELING & STATIONARY data logging
• Increase multi-tasking during tests – test plunger fall times, liquid level, bottom hole pressure survey, rising slug load & 4-point as a group
Programming

- Microprocessor settings are programmed on location via laptop computer.
- Sample rates of 1/second upward are set in a multi- or fixed-rate pattern for pressure & temperature.
- Temperature only units can sample @ 3/second when looking for tubing holes.
- Date & time are reset and battery installed.
- Data logger probe placed in STATIONARY or TRAVELING probe.
Stationary

- Ensure there is a bottom stop assembly in the tubing

- The **DROP OFF** plunger (left) attaches w/ collet to the fishneck of the **STATIONARY** plunger

- After plunger combination reaches bottom, **DROP OFF** plunger thermocouple activates at pre-determined temperature setting and separates from the fishneck of the **STATIONARY** plunger

- Well flows bringing **DROP OFF** plunger to surface
Traveling

• Data logger programmed in any of the Traveling plunger housings

• Plunger is dropped and operated like a conventional plunger

• Plunger housings are available in:
  – dual & triple pad
  – brush & bar stock
  – flow-thru design being tested
Retrieval

• Traveling Smart Plunger arrives in lubricator

• Retrieval Plungers are used to bring up Stationary Smart Plungers

• Padded Retrieval Plunger is dropped in well and an overshot grabs the Stationary Smart Plunger

• Well is flowed bringing both plungers to surface and caught in the lubricator
4-Point Isochronal Test – IPR Curve

- A Stationary Smart Plunger is set at the bottom of the well
- The Drop Off Plunger is removed after surfacing
- The well is flowed for a pre-set time
- A surface choke is changed to predetermined sizes during the flow test
- The Retrieval Plunger brings the Stationary Smart Plunger to surface after the test
- Data from Stationary Smart Plunger and surface is extrapolated into an IPR curve
Plunger Lift Optimization

- Traveling Smart Plunger can be used to temporarily replace existing plunger
- Surface controller settings can be changed as required
  Compare data from each setting change
- Using data, make final adjustments
- Fall times and build-up requirements usually show the most dramatic changes
Plunger Lift Optimization

- A Traveling & Stationary Smart Plunger can be used together to track cycle information
- Corresponding conditions from the bottom hole & various tubing locations are recorded simultaneously
- Data trends are merged to help isolate and identify events and verify signatures of common occurrences
- Controller settings - times and pressures - can be adjusted to optimize accordingly
Pressure Build Up

- A Stationary Smart Plunger is delivered to the bottom of the tubing via the Drop Off Plunger

OR

- A Traveling Smart Plunger is dropped and left at the well bottom
- Well is shut in, then plunger is removed at end of test
- Shown at left – typical example of plunger cycles followed by 48 hour build-up
**Plunger on bottom**

Smart Plunger tests discovered that some plungers were not hitting bottom – even with what was to believed to be more than adequate shut in times.

Both examples show the classic signature of being prematurely turned back on – no pressure build up.

One case was suspected prior to testing – the other was completely unknown.
Detect tubing holes

- Williams has shared part of their extensive Smart Plunger usage in this case of detecting a tubing leak/ hole

- Temperature only testing is done on 3 – sample/ second test settings in a triple pad plunger for slowest fall times & best results
Detect tubing tight spots

- Plunger travel is measured in feet/minute and countless tests have given reasonable rates for various designs – padded, brush, barstock, etc.

- Previously unseen in the industry, these graphs show what can only be detected by Smart Plunger data capture of pressure & temperature

- Both tubulars have definite plunger drag-hold-release points
**Compression drawdown**

- A well using time control to open-close over time periods – stopcock – was targeted to test what would happen if field compression would be used.

- Bottom hole flowing conditions were recorded during the process with a Stationary Smart Plunger.

- Field compression was designed on the base test template.
Reservoir analysis

- Smart Plungers use a high quality, extremely accurate data logger microprocessor to capture pressure & temperature data.

- Reservoir support is available to analyze formation properties through build-up surveys (below) to evaluate depletion rates, permeability, material balance, skin damage and more.
Multi-Stage Plunger Lift

- Recently new testing with four pressure & temperature points being recorded simultaneously – 2 Stationary, 2 Traveling – has shed light on Multi-Stage Plunger Lift operations
- New insight on where to set tools and boundaries
- Provides data to deal with Triple-Stage systems on a much more technical level
- Improved scheduling of service
- Better philosophy of how to run Multi-Stage controllers from surface